Center of Excellence for
Technology Education

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M. Winterbottom (Eds.)

Research in Technology Education

International Approaches

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Center of Excellence for
Technology Education (CETE)

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Marc J. de Vries, Stefan Fletcher, Stefan Kruse, Peter Labudde,
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Preface

The increasing use of technology in our lives not only requires the qualification of young professionals through vocational training in order to maintain innovation and technical and societal progress, but also a technical education "for everyone" so that we are able to cope with these environments and become a society with technology literacy.

Different theoretical frameworks describe tasks of Technology Education with the aim of developing technological literacy. In addition, contents are defined but have to be modified every now and then as the basis for the development of technology (e.g. 3D-printing, the energy revolution, modern manufacturing) and the current level of digitalisation.

Nevertheless, there is less data-based evidence about Technology Education. Data about the outcome, quality, effects or the development of competencies are rare.

Therefore, the scientific community, as well as the community of teachers and educators, does not know with certainty the most effective way to teach Technology Education. Furthermore, it is more difficult to argue in favor of Technology Education in educational policy without data.

Thus, the Centre of Excellence for Technology Education-Network (CETE-Network) has made it its business to investigate Technology Education to generate data and gain evidence.

CETE is an international network, consisting of leading universities within the sector of Technology and Engineering Education. It consists of six different Universities and their researchers (University of Missouri; University of Cambridge; University of Luxembourg; University of Applied Sciences and Arts Northwestern Switzerland; Delft University of Technology and University of Duisburg-Essen). Since 2015, the network has been funded by the Federal Ministry for Education and Research (BMBF) and by the German Academic Exchange Service (DAAD).

With its program, CETE also supports the qualification of young academics in the research field of Technology Education.

Investigations for generating data and the qualification of researchers are often linked. Thus, CETE organised an international summer school in 2016 to present the diversity of research work in Technology Education of different countries and to support this research work. The workshop considered research work of all school levels (from primary school to vocational training) and offered the opportunity for professional exchange and networking as well as workshops of methodological approaches in the research field of technology and engineering education.

The results of that international summer school are gathered in CETE's subsequent book. "Research in Technology Education – International Approaches" will present different research work:

Starting with two basic articles about the meaning and structure of Technology Education, seven different research works are presented, and three proceedings which give a perspective on future data.

Prof. Dr. Marc de Vries from Delft University of Technology talked about a better Image of Technology Education. In the international discussions about Technology Education, there is an increasing interest in STEM education as a possible context for future Technology Education. STEM education is a possible answer to the question as to how the status of Technology Education can be improved.

With a more detailed look at Technology Education at the primary school level, Ph.D. student Victoria Adenstedt from the University of Duisburg-Essen focuses on the importance of early Technology Education for the development of a technological self-concept of primary school pupils. A lack of technological experience may lead to the self-cognition of inaptitude and a lack of skills, which makes a responsible participation in social life more difficult and has an impact on identity development as well as on a future career choice.

Without innovations in the use of energy, mankind would have not achieved the current technological capabilities or the high quality of life possible today. This raises the question about which knowledge and attitudes people need to come to rational decisions when it comes to energy. The contribution from Ph.D. student Johannes Deutsch from the University of Duisburg-Essen focuses on the development and use of a diagnostic test to assess German students' energy literacy at the end of Secondary Level I (ages 14–16).

Analysing action-oriented engineering design problem-solving processes in Technology Education at a secondary educational level, the study of Tatiana Esau from the University of Duisburg-Essen aims at verifying the thesis that action-oriented learning processes are highly effective and learning in interaction with real objects is considered to be even more effective. She explores influencing factors using detailed information about individual solution processes with the help of eye-tracking systems.

Katie Klavenes teaches at a secondary school level and has a degree in Architecture, a PGCE in Design and Technology and an MPhil in Education at the University of Cambridge. Her research focus lies on gender disparity in STEM subjects and careers, which could be linked to the E-S theory of empathising and systemising. Her study identified the causes of gender disparity by investigating the relationship between brain type and gender in pupils in year 9 (ages 13 to 14).

Post-doc researcher Dr. Alexander Koch and research assistant Lena Wenger from the University of Applied Sciences Northwestern Switzerland explore technological socialisation and its impact on Technology Education in the classroom. They develop an empirical pilot study to assess student teachers' biography and instructional belief to investigate preconditions that support student teachers' pursuit of tech-oriented instruction in compulsory K-9 school, i. e. primary and lower-secondary school.

In her article Dr. Jennifer Stemmann, research assistant at the University of Duisburg-Essen, argues that problem solving competence in handling everyday technical devices is a two-dimensional construct. At first, she developed a theoretical construct of the cognitive psychology construct of 'competence to solve problems in handling everyday technical devices'. Second, she subsequently verifies it empirically by means of a computerised measuring instrument. The study will assess if the assumed dimensionality of the construct operationalised by the items of the test is shown in the behaviour of the test subjects.

The KOKO EA projects assessed vocational competencies of German electronics technicians for automation technology at the end of their vocational training. One of the constructs measured was the content knowledge in different areas. Leo van Waveren, from the Technische Universität Kaiserslautern, investigates in his article which influence is attributed by trainees to the places on knowledge gain. The paper aims to account for different response patterns and their impact on factor loading within the structural equation models.

A theoretical perspective on inquiry-based learning is the research focus of Prof. Dr. Charles Max at the University of Luxembourg. His article addresses the theoretical and methodological concerns of our research on inquiry-based learning processes. It examines to what extent sociocultural views on human knowing, learning and acting in the legacy of Vygotsky's cultural historical school of thought might be beneficial for analyzing student activity in technologically enhanced school environments.

In his contribution to the book, Dr. Stefan Kruse, researcher at the University of Applied Sciences Northwestern Switzerland, reports about a Swiss project with the goal of promoting common technical education through current issues with respect to "Mobility". The overall objective of the initiative is to prepare contemporary educational material relating to the automotive industry in the sense of case studies, which can be used for teaching and learning purposes. The project has a focus on both students and teachers.

Ph.D. student Benedikt Schwuchow from the TU Dortmund analyses activity orientation of Technology Education in higher education. In his investigation, he explores the combination of blended-Learning, problem-based learning and vocational activity orientation. CNC technology as a method of designing appropriate solutions helps the students to develop competencies and gain theoretically based knowledge at the same time. The design-based research setting evaluates the created learning environment. For this purpose, student's learning outcome and skills will be examined as well as the learning environment itself.

Teachers' scaffolding is one of the most influential factors on students' learning processes, especially in early childhood, which is one of the main approaches in Technology Education. Through practical problem-solving, children can understand the man-made world, involving, using and discovering scientific concepts and skills in conjunction with design-and-make activities. Ph.D. student and student teacher Julia Steinfeld, from the University of Duisburg-Essen and Centre for Teacher Training (ZfsL) in Paderborn, investigates teachers' scaffolding patterns and their cognitions in problem solving tasks in Technology Education in German primary schools via videotapes and stimulated recalls.

We would like to give our thanks to all who have contributed to the second international CETE book about research in Technology Education. Thanks to all CETE-members, authors, teachers and children worldwide who have supported the studies of the book. Speaking of support, we would like to offer an extra special thanks to Victoria Adenstedt for her collaboration on this book. Throughout the process of writing and publishing this book, her efforts helped to make this book complete.

Marc J. de Vries

The T and E in STEM: From promise to practice

Introduction

STEM has become a buzzword in Technology Education circles. The acronym stands for Science, Technology, Engineering and Mathematics. It is a rather fuzzy term, as there are many different interpretations. One extreme in the spectrum is that of S+T+E+M, meaning it is not a new type of education at all, but just an umbrella term under which a number of existing school subjects fall. The other extreme is integrated STEM, which means that all four subjects merge into one holistic subject that combines science, technology, engineering and mathematics. Depending on the interpretation there is quite a bit of controversy about STEM in Technology Education debates (Barlex 2009; Williams 2011). Here the extremes in the spectrum are, on the one hand, those who applaud STEM and see it as the only viable future for Technology Education and, on the other hand, those who refuse to come to a technology education conference when it has the acronym in the title[1]. The debate arises from the way promises and threats are weighed differently by different people. In order to get a feeling for the debate therefore it is necessary to take a closer look at both the promises and the threats.

Promises, promises ...

One of the promises refers to the nature of science, engineering and mathematics. Although in educational situations we often find them separate, in practice they are mostly combined. An example of this is industrial research. In industrial R&D, people are constantly switching between the development of new and/or improved devices and systems, and the acquisition of a deeper understanding of the phenomena that govern the functioning of those

1 This actually happened when in preparing the PATT-32 conference in the Netherlands, the title was changed due to the fact that some colleagues at the PATT-31 conference announced that they would not come to PATT-32 because the draft title had STEM in it. On the other hand, the PATT-31 conference programme had several presentations in which STEM was presented in very positive modes.

products. An example of an industrial research laboratory is that of Philips, of which the first 80 years of its existence were studied in detail (De Vries 2005). In several interviews people said that often they could not tell whether they were doing science or engineering that day. It was often a mixture. In their effort to improve an existing product like the glass bulb – Philips' original product – they felt the need to get a better understanding of the gas discharges that led to damages of the filament. But once they had acquired that knowledge, they realised that gas discharges could be used to construct a new type of lamp, in which the discharges were not an undesired side-effect, but the basis for its functioning. Thus, gas discharge lamps were invented. Another story in relation to this laboratory is that Philips could take up the challenge to get involved in X-ray tubes during WWI due to the fact that the lab knew 'all about glass and vacuum' because of their work on light bulbs, and that X-ray tubes in their view were nothing but glass and vacuum also. In a similar way, the company got involved in radio tubes (nothing but glass and vacuum again). Because it was commercially more interesting to produce whole radio sets rather than radio valves only, Philips started working on other elements in the radio sets also. Thus, they acquired expertise in acoustics, electromagnets and electrical circuits. That new expertise made them also start working on the acoustics of concert halls, on ceramic materials for magnet kernels and on a variety of components in electrical circuits. One of the extreme consequences of the work on ceramics was that Philips for a while produced toilet seats (!). So the explosion of the Philips' product portfolio in the 20th Century was all the result of continuously hopping back and forth between science and engineering. What they did was really STEM. Similar stories can be told for other industrial R&D labs. STEM is part and parcel of industrial practice and for that reason it is a way of showing a realistic image of science, engineering and mathematics to show how much they are intertwined in the real world of industry.

A second promise related to STEM is related to the negative image of science that pupils often hold. Science education has a reputation for being abstract and not recognizable in daily life (Sjøberg and Scheiner 2010). In itself science is indeed characterised by the abstract nature of its knowledge. The purpose of science is to acquire knowledge that can be generalized to the extreme of a 'grand theory of everything'. But in order to be so generic and independent of time and context, the knowledge must be abstract. This is what makes sciences a cognitive challenge for many pupils, as learning abstract concepts assumes the ability to distinguish between what is context-dependent and what is not. The colour of a chameleon is context-dependent, but the shape of its tongue is not. Thus the concept 'chameleon' is determined by its tongue, not by its colour (apart from the fact that there is some extra complexity in this example due to the fact that the changeability of the colour does belong to the concept of a 'chameleon'). It is known that for many pupils learning concepts at an abstract level right away demands too much of them. Many pupils need to get acquainted with concrete instances of the concept first, preferably in a variety of contexts. In other words: to learn the concept of a 'chameleon', pupils need to see a blue one sitting near the water, a red one on a tiled roof, a grey one on an asphalt road, and so on. Gradually they start realising that a chameleon can have different colours, but that the tongue is always of the same shape. Technology can offer a variety of contexts in which abstract science concepts can be taught and learnt. This makes science not only more accessible to all pupils, but also more fun.

A third promise has to do with the low status of technology education. In many countries, technology education still struggles with a low image due to its past in craft education (Jones, Buntting and Vries 2013). Parents and school boards still often associate the term 'technology education' with craft and do-it-yourself. Those can be useful and fun, but they do not have a high status in schools. That changes when technology education becomes a member of the science and mathematics subjects section. Those subjects are definitely seen as very important for future schooling, as well as cognitively selective and therefore suitable for identifying the better pupils. In the Netherlands, schools are free to have technology education as a separate subject or combine it with science (as long as the national standards are met). Many technology teachers have experienced a substantial growth in status after their subject was merged with science. Potentially STEM is the quick and easy way to get technology education 'above the critical line' in status.

The threats

Against these promises, the adversaries of STEM bring in some threats that prima facie seem quite realistic. Even when one is not discouraged and still decides to introduce STEM, a solution has to be found for the hurdles that these threats bring with them.

The first threat is that technology education will vaporize in the merger with science. This, too, can be illustrated by experiences in the Netherlands. In schools with a weak technology education programme (i. e., with a curriculum that was not well-defined and consisted merely of scattered workpieces and makingprojects), the science teacher quickly realised that the national standards had been formulated so vaguely that in principle they could be 'ticked off' by doing a one afternoon technology activity. At best, technology then functioned only as a stepping stone towards learning science during the remaining time. The fridge only functioned as a context for teaching thermodynamic principles, not to illustrate the process of product development in industry or the challenges of a design process. Science teachers can be tempted to reduce the influence of technology as much as possible as this can damage the image of science, which currently is that of an important subject, and 'polluting' it with technology could mean a threat to science. So STEM can easily be the end of technology education when the technology teacher is no match for the science teacher.

A second threat is that the infusion of science in technology education may take away a lot of the fun of technology education. In the current situation, technology education often has a 'designerly', open-ended, 'artistic' nature. Science could spoil the fun by emphasizing the need to work systematically, to bring in dull theoretical work, to make design more abstract and to make it more difficult. Science is the 'right-or-wrong' type of activity that hampers creative behaviour by demanding strict selection based on 'truth'. This in spite of the fact that these are not characteristics of real science (real science being a highly creative activity in which different explanations for a phenomenon may exist as different possible answers to a research challenge).

A third threat to STEM is that it does not contain all science, nor does it contain all technology. Science sometimes is done for the sake of pure curiosity. This is in fact the basis for 'inquiry-based' science education, which is another buzzword in contemporary discussion. The excitement of a phenomenon like the rainbow can be studied by pupils without any technological applicability as its driving force. And in 'real' science there are quite some examples in which applications are not considered during the research (for instance, in studying stars or quarks, to mention two extremes in size). But also from the side of technology there are such issues. Still today important domains in technology do not use very sophisticated science. People developing corkscrews smile when they read articles about forces in corkscrews as they know that when they try to found their designs on such considerations, probably not a single new corkscrew will ever be designed successfully (De Vries 1994). So STEM can never take over the complete science and technology curricula. But what should be done with the remaining elements? Do they justify separate subjects to remain next to STEM?

A fourth threat is in the expertise of teachers. Who will teach STEM? Ideally a dedicated STEM teacher, but for the time being we only have science, technology and math teachers. They have such different levels of expertise that none of them can teach STEM on his/her own. In that respect one should be critical about the optimism that is often displayed in ITEEA when technology teachers start calling themselves 'STEM teachers'. Does their knowledge of science justify that? Is their understanding of scientific research and concepts deep enough to teach science with sufficient quality (Bell 2016)? Most of them have a craft background and their knowledge of science is often the result of some in-service education. Most of them have by far not the level of expertise that science teachers have. On the other hand, how deep is the understanding of design with science teachers? Most of them have never gone through any significant design experience during their education. Similar limitations hold for mathematics teachers. Probably in most cases the idea of the school board will be that it is easier for the science teacher to improve his/her design capabilities than for a technology teacher to acquire a more fundamental understanding of all these abstract concepts in science. So the task of teaching STEM will then go to the science rather than the technology teacher.

The fourth and perhaps most fundamental threat is that it appears to be quite a challenge to develop integrated STEM projects in which there is a real connection between science, technology and mathematics. Many existing STEM projects suffer from one of the two following problems. The first problem is that a small scientific investigation is built into a design challenge, but the outcome of that investigation only leads to insights into scientific ideas and it does not have any impact on the design. Pupils will quickly recognize this artificiality in the design project and merely do the investigation for the teacher's sake and not because they get the impression it will improve their design. The other problem is the mirror image of the first: there are science activities with technical artefacts serving merely as a context in which to investigate a natural phenomenon. The understanding of the functioning of the device does not have any impact on the understanding of the scientific concept. That could have been the case when different devices based on the same scientific principle would serve as different contexts for learning the same concept and have been used to enable pupils to gradually develop an understanding in the abstract concept. In both cases, pupils will not experience STEM as meaningful.

The mysterious E

So far I have left out considerations about the E in STEM. That is because in practice there is no engineering education in primary and secondary schools in most countries. Some exceptions have been described in the book *Pre-university Engineering Education*, edited by De Vries, Gumaelius and Skogh (2016). But these are exceptions and even in those cases it is not always easy to identify the typical characteristics of engineering in those situations. Such characteristics are: the extensive use of modelling (contrary to current technology education in which models are made without any reflection on their nature), an important role for measuring and quantification (contrary to current technology education that is largely qualitative), the use of abstract concepts like systems, optimization, trade-off and the like (contrary to current technology education in which theory plays a minor role) and ample attention to human and social constraints (contrary to technology education where pupils often design for themselves rather than for a market) (Kaheti, Pearson and Feder, 2009). We do not find these characteristics in science and mathematics education either, so they would be a new element in the curriculum that the implementation of integrated STEM would bring with it. Many of these concepts can be claimed to be part of technological literacy. Having an understanding of the nature of systems is indispensable for understanding how technical devices work, but also for understanding how they influence humans and society.

The one characteristic element of engineering that does already feature in technology education is design. But clearly, design in engineering is different from most design in technology education, because it is infused with the elements of modelling, quantification and the use of concepts. The combination of T and E would bring together the more intuitive way of designing that we find mostly in technology education and the more quantitative and modelling-based type designing in engineering. Together, they could provide a clue for the problem of how to exploit the promises of STEM, while avoiding the pitfalls that result from the threats that were identified earlier.

A possible way forward

The route that will be suggested here does not do away with all STEM threats for technology education. But it does provide a perspective that potentially addresses most of the issues identified in the 'threats' section. The heart of the route is to use design challenges of a particular kind, namely those in which engineering principles, scientific concepts and mathematical ways of thinking are essential for finding solutions to the challenge. An example can illustrate this.

Assume we challenge pupils to design a boat for carrying cargo. Assume also that some pupils have incorrect preconceptions about sinking and floating. For instance, they may think that big things float (they may have seen big ships floating) and small things sink, or vice versa, that small things (like a cork) float and that big (and therefore heavy) things sink. When they design a boat based on those ideas, they will soon find out that many of their designs fail and sink. Then what we call a 'cognitive clash' is realised: pupils' intuitive ideas appear not to match with reality. This will make them prepared to question their intuitive ideas and seek better ones. By doing experiments (as in physics education, but by using also creativity in coming up with possible variables that may influence the sinking/floating behaviour and testing those in models) they will get an understanding of Archimedes' law. Furthermore, they will realise that calculations are necessary to find out how much water has to be pushed away by the boat to compensate for the weight of the boat. Even when trial and error takes them somewhat further, they will realise that calculations are certainly needed to optimise the design so that an optimal amount of cargo storage room becomes available. Modelling can be used to test this. This activity will result in a rich design experience, a better understanding of science concepts and new experiences in using mathematics. When this project is guided by the team teaching of a science teacher, a technology teacher and a math teacher, the presence of the necessary expertise is warranted.

Such an activity does justice to the nature of design as a process in which both new knowledge is developed (about designing itself, but also about science and engineering), and existing knowledge (previously learnt in science, technology and/or math education) is applied. By using all concepts simultaneously, the individual concepts will also become connected in the pupils' minds to form conceptual networks, which enable a more versatile use of the concepts. Now in this example, things come together convincingly. But of course one example is not enough to realise integrated STEM education. But is not creativity the 'specialité de la maison' for technology educators? Of all education specialists, they should be the first to show the ability to develop good examples of challenges and projects.

A second example can illustrate how in real engineering knowledge is developed in the context of designing. The design of airplanes still today is based on tinkering with prototypes and investigating the effect of systematically changing the design (longer or shorter wings, shifting the centre of gravity, etc.) of the flying behaviour of the airplane by putting models in wind tunnels. By studying, for instance, the way air moves around the wing profile, insights have been gained that eventually grew into the domain of aerodynamics. This process of simultaneously developing knowledge about natural phenomena and improving the design can easily be simulated in class by using paper airplane designing and testing. It will not result in an understanding of the fundamental laws of dynamics (De Vries 2010), but it will give an understanding in the nature of several variables that in physics can be studied in a more abstract way and thus yield more generic knowledge.

In conclusion, a design-based approach to STEM seems to be promising in that it exploits STEM's promises and provides opportunities for avoiding the pitfalls. The coming will show if this can serve as at least part of technology education's future. The potential is worth the effort. After all, we do want future citizens to get a realistic understanding of the STEM components and at the same time we want to give them experiences of the excitement of doing science, doing technology/engineering and doing mathematics.

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Victoria Adenstedt

How boys' and girls' technical interest differs: A research study

1. Introduction

Technology increasingly pervades all aspects of life, affecting the way we live our lives in our technologically oriented society. Paradoxically, it seems that today's children and young adults are less interested in studying technology, science and engineering. Over the last few decades, researchers have not only identified this problem, but have focused especially on the gap between boys' and girls' interest in technology (Schreiner & Sjøberg, 2004; OECD, 2008; Van den Berghe & De Martelaere, 2012; Ardies, De Maeyer & Gijbels, 2015).

Technological illiteracy develops out of a lack of technology socialization. This makes responsible participation in social life more difficult and has an impact on identity development (Acatech & VDI, 2009). A lack of technological experience may lead to self-cognitions of ineptitude and a lack of technological skills. The results are disinterest and aversion. This may affect students' choice of technologically oriented study courses and professions (Martschinke, 2014). Technological literacy, on the other hand, not only includes competencies, but also self-cognitions, e.g., self-concept, interest, self-esteem towards technology. By actively dealing with technology, the students build their self-cognitions in technology (Baumert & Geiser, 1996; Bandura, 1977).

To maintain technological innovation to maintain society, society needs technically literate males and females, and so must provide a good technology education. For children, the experiences and active interactions with technology are the most important sources for developing self-efficacy and unwavering confidence in their own abilities (Mammes & Tuncsoy, 2013; International Technology Education Association, 2007; Bandura, 1995). In German primary schools, technology education has become a compulsory part of natural , social and local studies at the primary school level ('Sachunterricht')[1]. This decision is meant to help develop technical interest at an early age and, in the long term, to help children become technically literate.

1 'Sachunterricht' is a German subject in primary school that combines different topics like Science, Culture, Geography, Social Sciences as well as Technology.

This study investigated how the technical interest of boys and girls in primary school in North Rhine-Westphalia differ. Based on the literature, it is expected that boys will have a higher technical interest than girls due to their higher cognitive interest, emotional positive acceptance and intrinsic motivation towards technology (Schreiner & Sjøberg, 2004).

Definition of 'interest'

According to Krapp & Prenzel (1992), interest is a long-term relationship between a person and an object with three aspects:
1. *Cognitive interest* = to be interested in the development of your knowledge about the object
2. *Emotional positive acceptance* = having good feelings for an object
3. *Intrinsic motivation* = an internal and individual motivation to deal with an object.

Previous studies have investigated how the development of interest starts in early childhood (Schiefele et. al., 1983; Vogt & Wieder, 1999; Upmeier zu Belzen et. al., 2002). Nevertheless, the structure of interest differs between children and adults. The interest of children is characterized by their individual preferences, is changeable and can be developed. By contrast, the interest of adults is characterized as an individual interest that is not open to change (Upmeier zu Belzen et al., 2002).

The concept of interest is characterized by the 'person-object theory of interest' (Upmeier zu Belzen & Vogt, 2001). This is presented in Figure 1.

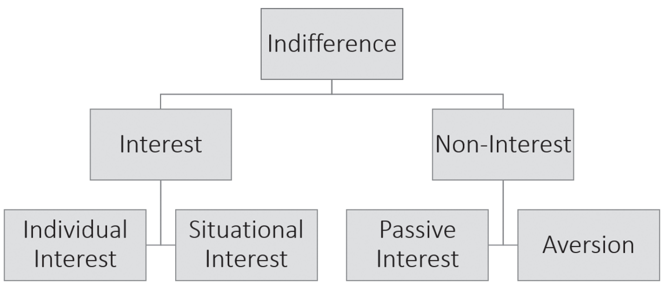

Figure 1: Characteristic features of interest

Indifference can be described as a neutral position; a person does not interact with the object and does not know anything about it. From this position, they can develop interest or non-interest (Upmeier zu Belzen & Vogt, 2001). Upmeier zu Belzen and Vogt sub-divided non-interest into two different characteristic features: passive disinterest and active disinterest, better known as aversion.

Passive disinterest happens when a person has not interacted with the object yet and knows of it only indirectly. There is no person-object relation in this type of non-interest. In contrast, aversion can be characterized as an emotional negative acceptance. At this point, a person has had negative experiences with the object. As a result, other situations in which the person has to deal with the object will be avoided (Upmeier zu Belzen & Vogt, 2001).

A positive interest can be associated with a cognitive interest in the objects, as well as positive individual feelings for the objects and intrinsic motivation to deal with them. From this, it follows that a person's interest in these objects may be short, or longer lasting (Krapp & Prenzel, 2011).

Situational interest can be developed by external factors, such as teaching and learning at school. Through such an experience, a person deals with the object and develops an emotionally positive acceptance for the object in that context or situation. At this level, situational interest can change into a longer-lasting interest in the form of an individual interest (Hidi & Renninger, 2010; Krapp & Prenzel, 2011). It is the schools' responsibility to create teaching and learning situations in which pupils can develop enthusiasm for and a positive individual interest in technology. Thus, interest is a key concept in technology education.

2. Interest by socialization

If we think of the strongest and possibly oldest categories in our society, it would be male and female. Our perceptions of life are stereotyped so that we have strong ideas of what counts as a male interest and what counts as a female interest. These kinds of perceptions have not really changed over time and still exist in our modern society (Berner, 2003).

Through industrialization and computerization in the 20th century, technical socialization has completely changed (Ziefle & Jacobs, 2009). Technologies have become omnipresent. However, technology is still associated with masculinity, as suggested by the male predominance in technical professions