

## **Technological and Inclusive Education**

### **Considering Students' Needs Towards Technological Learning in Primary Schools**

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*Research on technological education in interdisciplinary science and social studies (Sachunterricht) in German primary schools emphasizes that children are generally interested in technology. While several STEAM initiatives point towards a growing recognition of technological literacy, the consideration of technology education in interdisciplinary science and social studies is quite underrepresented in practice as well as in research and teacher training. Taking into account the UN-CRPD claims for an inclusive educational system and thus also the right to equally participate in a free society, participation in society through participation in technological development is a fundamental common goal of technological and inclusive education and part of widely recognized technological literacy. It is therefore not well understood how teaching and learning arrangements can consider and satisfy the needs of all different students. The research project the present paper is part of tries to unveil the appearance of student's basic needs in relation to technological education for all children. This initial quantitative part of a grounded theory study examined the subjective significance of basic psychological needs in interdisciplinary science studies in primary education to allow for a well-reasoned sample choice for subsequent interviews. Quantitative results point towards some revisions regarding the instrument used and several implications on the diversity of students' needs in science and social studies. Future research is needed with larger samples for factor-analysis.*

Keywords: basic needs, autonomy, competence, social relatedness, inclusion, grounded theory

#### **Introduction**

Research on technological education in interdisciplinary science studies (Sachunterricht) in German primary schools emphasizes that children, especially of young age, are quite interested in interacting with technological artifacts (Moeller 2018), solving technological problems (Beinbrech 2003) and discovering what something is made of, how it is crafted, used or disposed (Moeller 1998, Mammes 2001, Moeller & Wyssen 2018). While several STEAM initiatives such as “House of little scientists” (Haus der kleinen Forscher) point towards a growing recognition of technological literacy, the consideration of technological education in science and social studies is quite underrepresented in practice, research and teacher training (von Wensierski und Sigenege 2015, 122). Despite an increasing political (KMK 2017) and academic (Mammes & Zolg 2015) consensus on technological literacy as a key to participation in a society that develops and deals with more and more complex and diverse technological artifacts, problems and processes there is still little research on the development of teaching and learning technological education in Germany (Moeller & Wyssen 2018). In this context De Vries (2019) points out that there was serious reason for concern regarding the future development of research and teacher education of the subject in Germany due to a decline of research centers and chairs for technological education in recent years (82).

While much effort has been made on the development of scientific learning in science and social studies, revealing children's preconceptions on scientific contents and the effectiveness of teacher activities regarding diagnostic and scaffolding strategies (i.e. Blumberg 2008, Bohrmann 2017, Moeller & Labudde 2012), few advance has been made in research on technological education in primary school classes in the past decade (Moeller & Wyssen 2018).

Earlier empirical findings indicate that technological education is capable of supporting the personal development in general and particularly the self-efficacy in hands-on learning activities that satisfy the basic psychological needs for autonomy and competence among them (Tenberge 2002, p. 186f.). Beinbrech (2004) reveals, that solving technological problems in autonomy-supportive learning environments is more likely to foster both technological knowledge about gears *and* problem-solving skills than a less autonomy-supportive environment. She recommends an arrangement based on self-determined learning with the teacher structuring the process by the selection of technological problems (Beinbrech 2004, p. 214).

However, whilst several studies reveal that the satisfaction of basic psychological needs in general has a positive effect on learning outcomes and intrinsic motivation (Niemiec & Ryan 2009, p. 134; Krapp 2005, p. 639) barely any research specifies the individual variations in students' needs *and* among the needs of diverse students in primary education (Zhou, Ntoumanis & Thogersen-Ntoumani 2019, p. 325). Taking into account the UN-CRPD's claim for an inclusive educational system on all levels and therefore the necessity of inclusive classes and learning environments considering the diverse needs and potentials of all students the following question remains open: How can the needs of students in the context of the broad content of interdisciplinary science and social studies be described and considered when planning, executing or reflecting on interdisciplinary science and social studies classes?

### **Inclusive education in interdisciplinary science and social studies in Germany**

Educational systems in Germany tend to be highly segregating and selective especially on secondary level. Although German primary schools – founded in the early 20<sup>th</sup> century – are traditionally labelled as institutions for *all* children, still several tendencies fostering marginalization of pupils with disabilities or special educational needs have survived and seem to partly increase in contradiction to the UN-CRPD. In the term 2017/18 almost two thirds of the 486.680 students with the diagnosis 'special educational needs' went to separate schools for those children (Destatis 2019, 98). The joint schooling of all children develops slightly faster in primary schools than at secondary level but still the so-called inclusion rate (Inklusionsquote), which indicates how many children with special educational needs attend regular schools, was only 46,9% in primary schools in 2015/16 (Klemm 2015, p. 6). So more than half of all children diagnosed having special educational needs attend *exclusive* schools. As Booth and Ainscow (2002) deliberately define the term inclusion in their "Index for inclusion" as one not only affecting children with impairments the above mentioned statistics can only show part of how far the implementation of inclusive education has really proceeded in Germany. "Inclusion is about minimizing *all* barriers in education for *all* students" (ibid p. 3). The diagnosis of special educational needs and the associated allocation of financial and personnel resources – which is common practice – still are – next to others - capable of reproducing marginalization and stereotyping in so-called inclusive schools. Feuser (2016) states that all conceptualisations that foster these practices also integrate segregation into inclusion.

Taking the current quite unsatisfactory status of inclusive education in German primary schools into account it has not been sufficiently studied how inclusion can be implemented in primary schools in general and much less in the context of science and social studies. While several studies point towards positive effects of inclusive or integrative schooling (Blanck 2015, p. 166) it is not totally clear how teaching and learning can be organized in a way that the needs of all different students can be considered at the same time. Therefore the development of an inclusive educational system as claimed by the UN-CRPD (2006) could be fostered by arranging teaching in a way that takes the satisfaction of basic psychological needs into account.

As the UN-CRPD (2006) claims for "[...] an inclusive education system at all levels [...]", enabling *all* students "[...] to participate effectively in a free society" (16) participation in society through participation in technological development is a fundamental common goal of technological *and* inclusive education and part of widely recognized technological literacy.

Despite the fact that inclusive education in interdisciplinary science studies is still quite a marginal topic in Germany the number of publications on it has increased in recent years (Pech, Schomaker, Simon 2019, p. 11). Taking a look at research on the arrangement of inclusive science and social studies quite a few models and concepts have been developed. Yet very few of them have been sufficiently evaluated and some still reproduce a narrow understanding of inclusion, reducing it to the joint schooling of children with or without special educational needs (e.g. Kahlert & Heimlich 2014). The only fully developed and rudimentarily evaluated teaching and learning arrangements in science and social sciences considering inclusive education in a broad understanding by Schomaker (2000) and Seitz (2005) point towards a methodical and didactical opening of the arrangements and appreciative approaches to individual student patterns of interpretation of the environment.

An often mentioned but not yet theorized paradigm is that inclusive education should reveal and consider the potentials immanent to the current subject and the individual and especially consider and satisfy students' individual needs (Pech, Schomaker & Simon 2018, 15f.; Simon 2019, 58f.). In this regard, it has not been sufficiently studied how these needs appear in technological education classes and in particular how different needs can be considered by teachers or the arrangement of these classes. Especially the aforementioned empirical findings of Tenberge (2002) and Beinbrech (2004) point towards hands-on *and* minds-on learning activities as a promising approach to technological education although both of them did neither consider nor mention inclusive education in their studies due to the period in which they were implemented.

Building on these works and the implied research gaps the present article aims at clarifying on how the basic psychological needs for autonomy, competence and relatedness (Ryan & Deci 2017) appear in a science and social studies classroom. The basic idea of the research project the article is part of is to elaborate potentials and hindrances regarding the consideration of students' needs in primary school classes through a theoretical specification of the nature of pupils' needs. Advocating a broad definition of the term inclusion, this means to *not* especially look for the needs of students with or without impairments *but* to get past traditional categories and try to better understand the needs of *all* children. The research project (Fig. 1) is located in the methodological paradigm of reflexive grounded theory (Breuer, Muckel & Dieris 2017) and explores the appearance of students' needs during technologically learning. To achieve a well-reasoned sample choice (Emmel 2013, p. 33) for future interviews, second grade students have been polled on their individual desired satisfaction of basic psychological needs during science and social studies. The project component presented in this paper contains of first results from a pilot study of the questionnaire used.

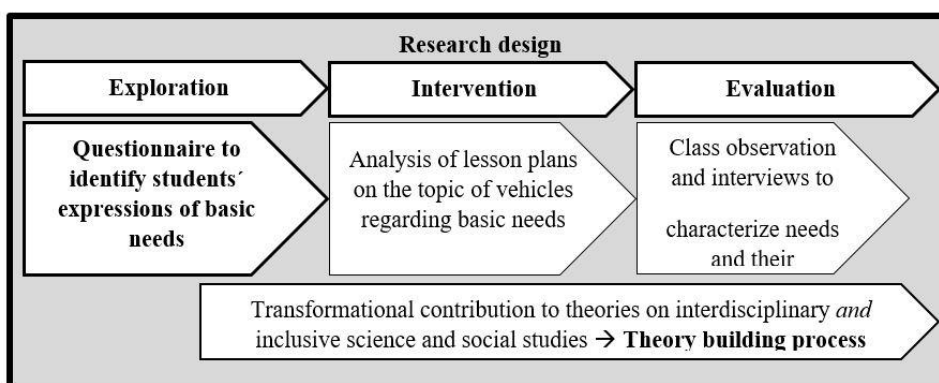


Figure 1. Research design

The paper falls into five further sections the first of which redeems the need for theoretical sensitivity on the understanding of basic psychological needs in educational contexts in a grounded theory study. The section below will substantiate the methodological positioning of the research project within the paradigm of grounded theory. Besides methodical concretions on the study presented in this article,

especially on the questionnaire used for the survey will be made. The paper goes on to present and discuss the results and identify cases for further research. Finally an outlook on the next methodical steps in the research project is presented and discussed.

### **Students' basic needs in educational contexts**

Widely recognized theorems on basic human needs postulate the fundamental differentiation between physiological and psychological needs immanent to every human individual (e.g. Nuttin 1984, p. 62). The underlying thesis is that human behavior always aims towards optimal relational functioning. Both physiological and psychological needs permanently affect human behaviour. But whilst physiological needs such as hunger or thirst do not tend to intensify over time, the common so-called basic psychological needs for autonomy, competence and relatedness (Ryan & Deci 2017) become more differentiated and intense the more they are satisfied (Krapp 2005, p. 631).

People may differ in terms of how subjectively salient these needs are or how centrally the needs are represented in their personal goals and lifestyles, and these individual differences might affect need satisfaction. (Ryan & Deci 2017, p. 242)

The quote shows that due to the perception of different living conditions such as parenting or teaching styles the individual expression of needs can differ. Furthermore, a quite fundamental issue to the expression of individual needs lies in their dependence on the current organizational surroundings.

Concerning the nature of psychological needs, Krapp (2005) postulates that they are not immediately apparent to the individual but strongly related to individual motives and goals towards objects. While motives and goals can be differentiated alongside the basic psychological needs, objects are subdivided into “[...] events and static objects, to people as well as situations or relationships; in other words, ‘object’ refers to all that can be perceived or desired.” (Nuttin 1984, p. 1).

The differentiation and definition of autonomy, competence and relatedness is widely recognized and quite common in most of the publications concerned. The individual need for autonomy refers to the perceived locus of control and represents the desire to be an independent centre of action. It is not understood as the perception of total freedom or absence of control. A decisive factor therefore is the perceived self-efficacy towards the aforementioned object which already indicates the strong interdependence with the need for competence. The second basic psychological need – the perception of competence - is described as the feeling of being capable of acting in relation to the object. A central issue is perceiving oneself as being up to the task but not being under- or overstrained. The third need for being socially related to significant others contains of the striving for being accepted and acknowledged through taking over their goals and motives. (Krapp 2005, p. 635f.)

While the explained basic differentiation of individual needs and their leading to a sense of wellness (Ryan & Deci 2017, p. 243) have been broadly studied their appearance while technologically learning has not yet been taken into account.

Hence the research project the present paper is part of investigates the following:

How are the needs of pupils within the context of hands-on technological learning activities constituted and how can different needs be considered by teachers or the didactical arrangement?

### **Location within the methodological paradigm of reflexive grounded theory**

Due to the not quite well understood appearance of students' needs in interdisciplinary science and social studies and because of the necessity to describe their formation and transformation in a holistic way, several conditions for exploratory, qualitative research access are given (Corbin & Strauss 2015, p. 5). The fundamental differentiation of the needs autonomy, competence and relatedness requires theoretical sensitivity on the one hand but is not sufficient only to fully describe the needs of pupils on

the other hand. The subject of research - the appearance and consideration of needs in the context of technological teaching and learning - requires theoretical enrichment. One central argument for the research approach of reflexive grounded theory (Breuer, Muckel, Dieris 2017) is the necessity for a greater focus on the needs of *all different* pupils as one key to welcome diversity and foster inclusive education. This makes it possible to constantly compare the different needs without taking traditional ways of distinguishing pupils in educational research into account (i.e. ability/disability, socioeconomic status, sex/gender etc.). A repetition of common focusses can therefore be avoided, and the reproduction of potentially discriminatory personal characteristics are reduced.

### Methodical concretion regarding quantitative data in grounded theory

“All is data” is a frequently cited phrase by Barney Glaser (2001, p. 145) a co-founder of the grounded theory that opens up a lot of various methodical opportunities. On the one hand therefore the fact of methodical openness is reflected. On the other hand it represents the necessity of a well-reasoned, purposeful data and sample choice aiming towards a theoretical saturation of the subject of research (Emmel 2013, p. 99). To select children for interviews according to different needs a questionnaire, trying to measure the subjective significance of the satisfaction of basic psychological needs was developed, considering the aforementioned theoretical implications on the basis of Nuttin’s (1984) and Ryan & Deci’s (2017) theories on psychological needs. Several content-related, validated instruments, all trying to measure the satisfaction of the basic needs within a situation or regarding the relationship with a person (i.e. parents, teachers, peers) were particularly used for a coherent formulation of the items (Barquero 2011; Vlachopoulos & Michailidou 2006; Heissel et al. 2018). The questionnaire in this first pilot study – aiming towards the validation of the developed instrument – included 40 forced-choice items, the first three of which served to make the procedure clear. Each of the other 37 items covered the expression or non-expression of one of the three basic needs for autonomy (16 Items), competence (9 Items) and social relatedness (12 Items). Each item had four levels two of which expressed the expression or possible expression and two expressed the non-expression or possible non-expression of a need.

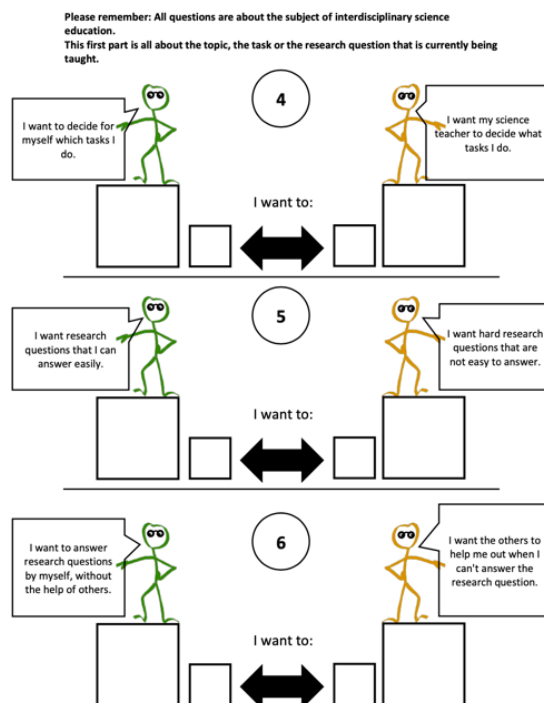


Figure 2. Translated item examples (Item 4: Autonomy, Item 5: Competence, Item 6: social relatedness)

The items were further differentiated according to two categories of objects towards which the needs are directed. Whereby the first category ‘subject’ was operationalized as a topic, problem or task and learning as an activity – taking a child-friendly language into account. The second category ‘event’ was operationalized as the positive or negative changing of a situation such as doing something wrong, making a mistake, recognizing that you are very good at something or getting help from others. The polled students were asked to tick whether they identify more with the green (left side) or the yellow (right side) child’s statement. Three translated examples covering each one of the three basic needs in the subject category are presented in figure 2

The sample consisted of eight female and 13 male students from one second grade class in a primary school in Muenster (n = 21). To avoid the sample falling into the aforementioned traditional variables such as ability and disability, no further personal variables were collected.

Considering research ethics according to applicable regulations, declarations of consent were collected from the parents of all surveyed children. Results were anonymized after the survey. The teacher of the class confirmed that all children were able to read sufficiently. None of the polled students were dependent on additional adult help due to migration-related bilingualism, insufficient language skills or cognitive overload. To guarantee that all students understood the questions, all instructions and the items were read out aloud slowly to the class one by one. Pictographs were added to the items to make them more understandable. Additionally the items serving to make the procedure clear were visualized in a poster and the students were given the possibility to ask questions. The investigation was conducted in July 2019 and took 35 minutes.

For the evaluation of the collected data the SPSS Software was used. Next to descriptive analysis of the constructs implemented, inferential statistics regarding correlations among them were analyzed and will be presented in the following section.

## Results

It has to be mentioned that due to the small sample size, the validity of the presented results is very low. Still, they can provide information on whether the polled children did understand the questions provided – especially as far as a groups’ diversity is concerned. The results on the nature of children’s needs are to be analyzed and understood as preliminary and interpreted carefully.

As a first step descriptive statistics for the total of 37 items were calculated. Regarding the subjective significance of basic psychological needs the results show an average which is slightly above the arithmetic mean of 2.5 including all 37 items (M=2.6178; SD=.33; Min.=2.05; Max.=3.11).

In this second section the results are presented structured by the three basic needs autonomy (*AUT*), competence (*COM*) and social relatedness (*SR*). The subjective significance of the need for competence (*COM*) (M=2,7905; SD=.66; Min.=1,3; Max.=4,0) and social relatedness (*SR*) (M=2,8571; SD=.79; Min.=1,27; Max.=4,0) are slightly but not significantly above average. The need for autonomy (*AUT*) (M=2,3452 SD=.64; Min.=1,19; Max.=3,88) is slightly below average.

Thirdly the results are presented with further differentiation regarding the implemented categories *event* and *subject*. Most of the implemented constructs show a satisfactory internal consistency. Taking the implemented categories of objects ‘subject’ and ‘event’ into account all three constructs for ‘subject’ were internally consistent to a satisfactory degree (*AUT*  $\alpha = .739$ ; *COM*  $\alpha = .898$ ; *SR*  $\alpha = .899$ ). For the category ‘event’ all three constructs did not reach a satisfactory level of internal consistency (*AUT*  $\alpha = .636$ ; *COM*  $\alpha = .642$ ; *SR*  $\alpha = .616$ ). The overall needs, putting the object categories aside, again all reached a satisfactory level (*AUT*  $\alpha = .813$ ; *COM*  $\alpha = .777$ ; *SR*  $\alpha = .846$ ).

Finally in this last section correlations between the three basic needs are presented after arithmetical cleansing. The arithmetical cleansing of non-satisfactory constructs led to an increase of internal consistency up to .782 for *AUT*, .759 for *COM* and .698 for *SR*. Hence the internal consistency did not quite reach a satisfactory level for the object category ‘event’.

The small number of polled students and especially the aforementioned partially satisfactory content validity of the implemented constructs only allow a cautious calculation of correlations among them.

The results show that the subjective significance of the need for autonomy correlates in a highly significant negative way with the need for social relatedness ( $r = -.507$ ,  $p = .019^*$ ). Furthermore the analysis found a medium highly significant positive correlation between the subjective significance of social relatedness *and* competence ( $r = .436$ ,  $p = .048^*$ ). Autonomy *and* competence do correlate weakly negative but not significantly ( $r = -.260$   $p = .256$ ).

## Discussion

Taking into account the research question on the constitution of needs in interdisciplinary science and social studies the study offers for discussion on the adequacy of the testing instrument used and on what can be inferred about the nature and diversity of pupils needs.

Low internal consistency scores among the object category ‘event’ indicate partially that some of the items seem to be formulated too complexly. It is reasonable to assume that compared to the category ‘subject’ some items have too complex subordinate clause constructions (e.g. If I can do something well, I want to continue learning on my own.). Moreover, it can be assumed that the operationalization included too many different and partially contradicting variations. The general layout of the instrument however seems to provide quite reliable results, which will have to be further scrutinized in pilot studies and factor analysis.

One fundamental result of this pilot study is that - as assumed - the subjective significance of basic needs seem to be divers within students and among different students. The analysis of correlations between the constructs implemented, even for the small sample size polled, offers the identification of various cases for further research. The findings increase the intriguing possibility that children, although of young age, differ in their individually desired arrangement of teaching and learning. The study points at the possibility that for example children differ in their desired degree of autonomy in science and social studies. In addition, children who prefer a high degree of autonomy tend to find social relatedness within their class and to the teacher less important and vice versa. Putting this in the context of the study it would be of interest how these different children describe their teaching and learning experiences during technological education lessons and under which conditions they prefer rather self-determined or controlled, socially related or isolated behaviour. Additionally the correlations among the subjective significance of competence and social relatedness question when different children feel capable of acting. Is it important to them that they are challenged by difficult tasks or the teacher or do they prefer to work on routine tasks or topics that appear common already?

The findings of this study are in line with prior research to the extent that the significance of satisfaction of basic psychological needs is related to present circumstances and previous experience (Krapp 2005, p. 631). It has - to some extent - become evident that prior research on the degree of satisfaction of basic needs in a relationship or regarding given situations cannot fully cover the complexity of students’ needs.

Finally, for the theory-building process it is open to what extent teachers are aware of the different needs of students and what strategies are used to take them into account. It is reasonable to assume that the broad variety of contents in the concept of science and social studies as one interdisciplinary school subject in primary education might be more likely to meet the divers needs of students than in other subjects although students’ needs are not exclusively related to the content or topic. Regarding Nuttin’s (1984) definition of objects needs can just as well be directed to a person, a method or type of task. Deci & Ryan (1991) give first hints for deductive categorization of strategies to consider students’ needs. The support of autonomy as antinomy for controlling teaching arrangements favours the satisfaction of the need for autonomy (p.245). The implementation of clear structures and demands as well as an autonomy supportive feedback could serve to satisfy the need for competence and finally appreciation by

significant others (e.g. being interested in and devote time and energy to a relationship) to satisfy the need for social relatedness (p.246).

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