Research on Interest in Science: Theories, Methods and Findings
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HAL Id: hal-00658698
https://hal.archives-ouvertes.fr/hal-00658698
Submitted on 11 Jan 2012

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<th>Journal:</th>
<th>International Journal of Science Education</th>
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<td>Manuscript ID:</td>
<td>TSED-2010-0327-A</td>
</tr>
<tr>
<td>Manuscript Type:</td>
<td>Special Issue Research Paper</td>
</tr>
<tr>
<td>Keywords:</td>
<td>attitudes, interest in science, large-scale surveys</td>
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<tr>
<td>Keywords (user):</td>
<td>motivation, research methods</td>
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URL: http://mc.manuscriptcentral.com/tsed  Email: editor_ijse@hotmail.co.uk
Research on Interest in Science: Theories, Methods and Findings

Abstract

This article presents an overview of interest research and describes the theoretical and methodological background for the assessment of interest in science in large-scale assessments like the “Programme for International Student Assessment” (PISA). The paper starts with a short retrospective on the history of interest, bringing out theoretical roots that help to understand recent discussions on interest in science education. As interest is a widely used concept with manifold facets, it is essential to discuss different ways of modelling the relationship between a person and a comprehensive object like Science with all of its different aspects, including wide ranges of content as well as contexts. Models that can be used for describing the content structure of science interest and the process of interest development are presented. Based on an overview of typical methods for assessing interests, exemplary findings on students’ interest in science are presented which play an important role in the current scientific debate. Finally, challenges for future research on interest in science education are discussed.
What prompts people to spend their lifetime examining scientific phenomena? Researchers’ typical answer to this question is: We want to understand the objects we examine, we want to know how things work—it interests us. This interest in knowledge is the driving force behind research.

What prompts young people to engage with scientific questions and to want to find things out about science and technology? As grown-up scientists were once children, perhaps it is the case that they have been driven by a specific cognitive interest since they were young. One could also assume that some people simply stand out by the special interest they have—in science, for example—and that this is how future scientists are formed.

Unfortunately, however, the actual facts are much more complex, and when things get complicated, what is needed is research that also looks into the phenomenon of interest. Why do complications that require scientific clarification occur? For example, a large number of scientists are required, but only a few people in the adolescent generation are so interested in this area that they aim at a professional qualification and career in this field (European Commission, 2004, 2006; Organisation for Economic Co-operation and Development [OECD], 2008). How can this be explained? Are there perhaps competing interests or other motives which influence decisions about further study and future careers? A further complication is related to the fact that although children and young people’s interest can motivate them to explore certain things, they may thereby ignore everything which has already been discovered by other people before them. Thus, it is also important to engage with others’ knowledge and to more or less systematically learn from others. What effect does this have on interest? And what is the effect of the way in which access to science is mediated?

It seems to be the case that young children are interested in all sorts of things, so how do selection processes take place, how are interests channelled? What is the role of ability and successful engagements leading to a noticeable learning progress? How can interest in science be awakened and maintained in general? After all, nowadays, it is not only a question of
gaining new blood in the field of science. Science concerns everybody—in both everyday and professional life (Bybee, 1997; Fensham, 1985; Millar & Osborne, 1998). We constantly have to make decisions which can only be considered to be reasonable if they take scientific evidence into account. But how can basic scientific knowledge be acquired—both in and out of school—and how does one keep up with new developments, for example, after leaving school? Is interest the motivation that steers lifelong development?

This brief outline of the problem reveals typical questions for research on interest in science and shows that several disciplines are required. Science education alongside educational psychology and educational research can contribute to a better understanding of how interest in science is developed, how it expands or disappears and how it can be promoted.

In this overview, we will therefore present relevant theories and findings from these fields. In order to classify the research approaches, it is helpful to first take a look at the history of interest research. Against this background, theoretical models will then be presented with which the interest construct can be specified and empirically surveyed, and its development reconstructed. We will devote a separate section to the methods used in interest research. From the viewpoint of science education, theoretical models which clarify the conditions behind interest development are particularly important. Therefore, exemplary research approaches and findings on research on interest in science which play an important role in the current scientific debate will be the focus.

**Historical Review**

The importance which the concept of interest can have in educational contexts was highlighted by great scholars centuries ago, e.g. Johann Amos Comenius (1592–1670) or Jean Jacques Rousseau (1712–1778). It was Johann Friedrich Herbart (1776–1841) who for the first time developed a general theory of education in which interest played a central role. He emphasised that interest must not only be regarded as a desirable motivational condition of
learning but also as an important goal or outcome of education.

Herbart’s ideas were adopted by authors at the turn of the twentieth century, for example by William James (1842–1910) and John Dewey (1859–1952). In particular, Dewey’s book *Interest and Effort in Education* (Dewey, 1913) influenced further research.

At the beginning of the twentieth century, the interest concept was used in different fields of educational and psychological research aiming at a better understanding of learning conditions or decisions about educational or vocational careers. The increasingly divergent use of the term ‘interest’ in different contexts of an emerging empirical research, however, promoted the development of new theoretical approaches and psychological constructs. Thus, research on phenomena of interest in the middle of the twentieth century focused on attention (Deutsch & Deutsch, 1963), curiosity (Berlyne, 1960) or intrinsic motivation (Hunt, 1965). Only the area of vocational psychology has maintained interest as an established theoretical construct (e.g. Strong, 1943).

In the last decades of the twentieth century, various areas of research witnessed a renaissance of the interest construct. This was due to the recognition that the concepts and theories developed in the specialised fields of motivation research do not adequately account for important phenomena that were addressed in earlier theories on interest such as the content specificity of learning motivation (Krapp, Hidi, & Renninger, 1992; Schiefele, 1978). The renaissance of interest theories was also supported by constructivist thinking emphasising a new understanding of the subject in interaction with the physical, social and cultural environment.

Because of its focus on specific content (objects, domains) the concept of interest seemed to be appropriate to understand tendencies of students or adults to engage in certain themes or contexts—or to withdraw from them. It was reasonable that studies on attitudes towards science and technology took up the concept of interest (Gardner, 1975; Ormerod & Duckworth, 1975), examining the ‘swing from science’ in the 1970s. The starting point for
these discussions was formed by empirical findings about the increasingly critical attitude of the population towards science and technology and the related disappearing interest in these subjects in secondary and tertiary education (Gardner, 1975, 1985). Rather influential was a study commissioned by the Department of Education and Science in England (UK) on the ‘flow of students of science and technology in higher education’ (Dainton, 1968). In many countries, research projects were initiated in order to examine the decline of interest and science-related attitudes more closely and to explore effective measures on how to work against this.

During these decades science education discovered the concept of interest, and manifold research initiatives were started in collaboration with neighbouring disciplines (e.g. educational psychology, sociology). The findings of these research approaches have been discussed at international conferences since the 1980s (Hoffmann, Krapp, Renninger, & Baumert, 1998b; Lehrke, Hoffmann, & Gardner, 1985; Lie, 1983). In the 1990s, the international and interdisciplinary exchange (Hoffmann et al., 1998b; Osborne, Simon, & Collins, 2003; Renninger, Hidi, & Krapp, 1992) and the discussion about consequences concerning necessary reforms of the educational system (Bennett, 2001; OECD, 2006b; Osborne & Dillon, 2008; Roberts, 2002) was increasingly intensified.

During the past two decades research in different areas of science education has substantially contributed to the informed discussion about the role of interest in learning and human development in modern societies. The recognition of interest as a component of scientific literacy in the framework for PISA 2006 provides an opportunity to broaden our knowledge in this area.

**Theoretical Foundations**

The interest concept is used in different ways in the literature on science education. This is partially due to the fact that the authors orient themselves towards different theoretical models and research paradigms.
The Meaning of Interest

There are numerous publications on the meaning of the interest construct in everyday and scientific language use (e.g. Berlyne, 1949; Silvia, 2006; White, 1967). General agreement can be found with regard to the central characteristics of the interest construct, for example that it is a multidimensional construct whose operational-definition requires both cognitive and emotional categories (Gardner, 1996; Hidi, Renninger, & Krapp, 2004; Schiefele, 2009). Interest is sometimes characterised as an ‘affective variable’ (Rennie & Punch, 1991; Steinkamp & Maehr, 1983). However, it is important to note that interest cannot be equated with ‘enjoyment while learning’. Enjoyment can occur for many reasons, and interest is only one of these.

The decisive criterion of the interest construct which enables it to be clearly distinguished from several neighbouring motivational concepts is its content specificity. An interest is always directed towards an object, activity, field of knowledge or goal: ‘One cannot simply have an interest: one must be interested in something’ (Gardner, 1996, p. 6).

There are different views about the relationship between the concepts of attitude and interest. Some authors suggest using both concepts synonymously (Schreiner, 2006; Schreiner & Sjøberg, 2004). Other authors (e.g. Osborne et al., 2003) see attitude as the superordinate concept and interpret interest as a specific form of attitude, characterised by a certain object area. Gardner (1996, 1998) and other authors, however, point out that both concepts can be clearly distinguished from one another. A decisive difference arises with respect to the evaluation criteria that are the focus. General, nonpersonal evaluation viewpoints are decisive for an attitude towards a particular object, whereas the subjective value attached to the knowledge about this object is important for interest. These two evaluation aspects are independent of each other. It is, for example, possible to have a pronouncedly negative attitude towards an issue (e.g. racism), yet have a strong and enduring interest to understand this topic.
Theoretical Considerations on Specifying the Interest Construct

In recent theories, interest is mostly understood as a phenomenon that emerges from an individual’s interaction with his or her environment (Hidi & Renninger, 2006; Silvia, 2006). This postulate is also the starting point of an educational theory of interest (Prenzel, 1992; Schiefele, Krapp, Prenzel, Heiland, & Kasten, 1983), also called ‘person-object theory of interest’ (Krapp, 2002a, b). According to this theory interests evolve out of manifold relationships between persons and objects in social and institutional settings. An interest represents a specific and distinguished relationship between a person and an object. An object can refer to concrete things, a topic, a subject-matter or an abstract idea, i.e. a certain part of the cognitively represented environment. A person will develop an interest for some of these objects for a shorter or longer period of time.

The interest relation to an object is characterised by certain cognitive and affective components (Hidi et al., 2004). The most important characteristics refer to an individual’s values and feelings (Schiefele, 2009). Any interest has the quality of personal significance, and it is associated with positive experiential states. Thus, interest-based interactions with the environment provide optimal experiential modes that combine positive cognitive qualities (e.g. thoughts on meaningful goals) and positive affective qualities. Given optimal conditions, flow may be experienced during interest-based activities (Csikszentmihalyi, 1975, 1990).

A further essential feature of interest is its intrinsic character. Interest-based activities meet the criterion of ‘self-intentionality’, which means that an interest-related goal is compatible with one’s preferred values and ideals. In general, an interest is associated with a pronounced readiness to acquire new domain-specific knowledge (a cognitive-epistemic component). As a result highly interested students are characterised by a comparably differentiated knowledge structure in the corresponding object area. The same is true of metacognitive knowledge. Those who are highly interested are well aware of what else there
is to know and to explore in ‘the zone of proximal development’ (Prenzel, 1988, 1992; Vygotsky, 1978).

The emergence and impact of interest can be examined on different levels of analysis. On the first level, interest refers to the dispositional (or ‘habitual’) motivational structure of an individual. Here, interest is interpreted as a relatively stable tendency to occupy oneself with an object of interest. On this level, one usually speaks of individual interest. On the second level, interest refers to current engagements. It describes a state or an ongoing process during an actual interest-based activity. This is the case when we observe the learning behaviour of a student and characterise his or her motivational state as ‘being interested’. This psychological state involves focused attention, increased cognitive functioning, persistence and affective involvement. An actually ‘operating’ interest can either be caused by an already existing dispositional (individual) interest or by the special conditions of a teaching or learning or work situation (interestingness). An interest that is primarily caused by external factors is called a situational interest (Hidi, 1990). It may be transitory or may provide the basis of a longer-lasting interest (Hidi & Renninger, 2006; Krapp, 2002b).

Concepts and Models for Describing the Content Structure of Interest

An important aspect of the interest construct is its domain specificity. The object or content area of an interest can either be characterised in a general way by referring to a broad area of knowledge or possibilities of interaction with the environment (e.g. a scientific discipline), or by describing specific topics, activities, etc. in which a person is actually interested.

A well-known theoretical concept that describes interest orientations at a very high level of generality is Holland’s RIASEC-typology comprising six personality types (Realistic, Investigative, Artistic, Social, Enterprising and Conventional). Each type represents a complex cluster of attitudes, self-beliefs, values and interests (Holland, 1997). Science interests most likely occur when an individual’s personality structure represents the
investigative type. Holland’s model provides a theoretical basis for measuring general interest orientations which are presumed to remain stable over a period of time and can therefore be used to explain or predict students’ school subject preferences and choices (Elsworth, Harvey-Beavis, Ainley, & Fabris, 1999), expected success in higher education or vocational decisions and career satisfaction (Silvia, 2006).

The level of generality in Holland’s model seems to be too broad for attempts to describe the interest of students in national or international assessments (like PISA). It can be expected that an ‘investigative’ or ‘realistic’ personality type tends to be more interested in science than a ‘social’ or ‘artistic’ type; however, the categories of this typology do not allow students’ interests to be differentiated in an educationally meaningful way.

**Interests in science** can be defined at a more generalised or a more concrete level. In the first case, the content area of science interest would comprise the whole body of science-related subjects and topics of which a person is aware. In the second case, one would take into account that an individual’s science interest can be limited to a particular school subject (e.g. biology, but not physics or chemistry) or to particular topics and activities within a subject domain (e.g. acquiring knowledge about the structure of the human brain; playing a musical instrument), a discipline (e.g. physiology) or a research field (e.g. ocean research).

In order to distinguish between different kinds of science interests, it is obvious to refer to the structure of school subjects because these mainly provide the opportunities to get in touch with sciences systematically. In fact, there are students who are highly interested in one subject (e.g. biology), but not in other science subjects such as chemistry or physics.

From a theoretical perspective, this level of differentiation for characterising the content structure of students’ interest in science remains too rough and beyond the classifications at hand, e.g. from Science Education. In addition to a differentiation of contents and themes, others aspects like contexts or areas of application can help to describe profiles of interest in science (see below).
Gardner and Tamir (1989) have proposed a multidimensional concept for describing interest in biology. Another example of a theoretically and empirically well-founded topological model was developed at the Leibniz Institute for Science Education (IPN) in order to assess the interest of students in physics (Haeussler, 1987; Haeussler & Hofmann, 2000). The model differentiates between three main dimensions of interest: (a) interest in a particular topic of physics; (b) interest in a particular context in which a physical topic is presented; and (c) interest in the particular activity a student is allowed to engage in in conjunction with that topic. Each of the three dimensions (topics, contexts, activities) is further broken down into subcategories resulting in a relatively complex overall model with eight content categories, seven context areas and four kinds of activities. This model has been used as a theoretical basis for the repeated measurement of students’ interest in physics in a longitudinal study (see below). The idea to reconstruct students’ science interest on the basis of a multidimensional topological model has been partly realised in PISA 2006 with the innovative methodical concept of contextualised items (McCrae, 2009; OECD, 2006a).

Theoretical Models for Reconstructing the Process of Interest Development

Large-scale assessments like PISA 2006 are limited to cross-sectional data which cannot be used for analysing developmental trends or the validation of developmental hypotheses. Nevertheless, developmental concepts and models are relevant for the interpretation of findings (e.g. differences between subpopulations) and for a discussion of interpretations that have to be drawn from these results.

Two kinds of developmental questions are of special importance: Is it possible to identify typical stages in the development of interest in science? And how can the mostly negative developmental trends of the average science interest in student populations be explained?

Models about typical stages of interest development. Travers (1978), Gottfredson (1981), Todt and Schreiber (1998) and other authors have postulated a regular sequence of
developmental stages from childhood to late adolescence. According to these theories one can assume a longer-lasting developmental period from preschool to primary school age in which all children are interested in all kinds of natural phenomena. Even very young children tend to observe their environment in a systematic manner; they enjoy new experiences, and are ready to learn more about natural phenomena with which they are confronted. From primary to secondary school, interest will be shaped: Children develop preferences for certain areas (e.g. animate nature, technology) and perceive their strengths and weaknesses in accordance with their experiences in science lessons in school. A critical phase for the development of science interest is adolescence, when students start to clarify their personal aims and ambitions (identity).

A second approach to describing interest development is based on the aforementioned distinction between situational and individual interest. During the life course, a person is interested in many things. Interests which are induced from outside are often kept ‘alive’ for only a short period of time. This holds especially true for subject areas that are first accessible in school, such as chemistry of physics. Nevertheless, it is possible that under certain conditions, a longer-lasting interest may grow out of a situational interest created by the interesting ‘composition’ of a teaching situation.

Krapp (2002b) has proposed to reconstruct this developmental shift on the basis of a model which represents three prototypical stages of interest development: (a) an emerging situational interest awakened or triggered by external stimuli for the first time; (b) a stabilised situational interest that lasts during a certain (limited) learning phase; and (c) an individual interest that represents a relatively enduring predisposition to engage in a certain object area of interest. The first occurrence of a situational interest is primarily a matter of the specific motivational quality of a learning situation or learning task, which is usually described as interestingness. With respect to educational aims the next two stages of interest development are of central importance. They include two qualitatively different steps of interest
development: first, the shift from the transitional state of actual attraction or curiosity to a 
more stable motivational state which is a necessary condition for effective learning, and 
second, the shift from a rather stabilised situational interest to a more or less enduring 
individual interest.

In their ‘four-phase model of interest’, Hidi and Renninger (2006) also distinguish 
between two levels (or phases) of situational interest (triggered and maintained situational 
interest). This model is characterised by a further plausible distinction between an ‘emerging’ 
and a ‘well-developed’ individual interest. Although the whole (intra-individual) process of 
interest development must of course be interpreted as a continuum, it is theoretically 
meaningful to postulate typical stages or phases because they provide a practically useful 
heuristic that helps teachers to analyse and evaluate students’ actual or desired motivational 
status.

Theoretical interpretations of observed developmental trends. Survey data 
gathered in student populations are mostly used to identify general developmental trends or 
trajectories that represent changes of aggregated interest scores in a certain domain or subject 
area over a period of time. Clearly negative trends can often be found with respect to interest 
in science (and related attitudes)--especially for the subject areas of physics and chemistry 
(Baumert & Köller, 1998; Daniels, 2008; Gottfried, Fleming, & Gottfried, 2001; Osborne et 
al., 2003; see below).

A number of explanations have been offered in the literature. Three explanatory 
approaches are of special importance for our discussion. The first approach supposes that the 
development of science interest is primarily dependent on the quality and type of instruction. 
There are numerous hypotheses about the emergence, promotion or hindrance of school-
related interests which concern, amongst others, the school’s organisation, the curriculum or 
the degree to which the general environment in the schools fit the students’ actual needs and 
desires (Eccles & Midgley, 1989).
A second explanatory approach is based on findings and theories from the field of developmental psychology. It is postulated, for example, that students in adolescence tend to give priority to the coping with new developmental tasks and are no longer ready to invest all of their energy in academic learning (Andermann & Maehr, 1994; Hofer, 2010 in press).

A third kind of explanation, the so-called differentiation hypothesis, assumes that the decline of the average science interest during adolescence stems primarily from the fact that young people, when searching for their own identity, subject their abilities and interests to a critical evaluation. All interests which do not seem to be compatible with the ideal self-concept are devalued and excluded from the student’s personally important interest pattern (Todt, Drewes & Heils, 1994, Travers, 1978). From this perspective, the negative development trend in the student population, is thus first and foremost an inevitable consequence of the normal differentiation of interest which occurs in adolescence (Daniels, 2008).

Methods for Assessing Interests in Science

The research strategies and measuring methods implemented in empirical studies vary depending on the research questions being pursued. In this section, we will give a short overview of typical measuring procedures. A more detailed description of the PISA 2006 interest assessment can be found in OECD (2006a, 2009b).

Most research approaches use questionnaires or rating scales to measure certain aspects of the interest construct. Often-used measures refer to students’ perceived interestingness of school subjects or students’ general interest in science. An important, but only seldom-realised methodical approach attempts to reconstruct the topological structure of science interest in a particular domain (e.g. physics). Furthermore, there are methods which do not aim at measuring science interest directly but provide information about variables that are in a theoretically convincing way associated with science interest. In PISA 2006, for example, the following measures belong to this category: enjoyment of science, personal
value of science, science-related activities, future-oriented motivation to learn science and
expectations for a scientific career at age 30.

Methods for Surveying Interest in School Subjects and Scientific Domains

In survey studies, interest is often measured on the basis of simple rating scales or
short questionnaires in which the subjects are requested to estimate the perceived
interestingness of a subject or to assess their personal interest in this subject area. It is,
however, often doubtful which aspect of interest is indicated in the students’ answers to these
questions. Haeussler and Hoffmann (2000) suggest making a distinction between ‘domain
interest’ and ‘subject interest’. In the first case, a student is primarily interested in the contents
of a domain that are taught in the lessons of a particular school subject (e.g. knowledge about
the functions of the human brain). In the second case, the students’ expressions of interest are
related to the school subject according to how it is being taught in school at that point in time.
As a rule, students’ generalised evaluations of the ‘interestingness’ of school subjects are not
only (or primarily) determined by the kind of knowledge they expect to acquire in the lessons
(domain interest) but also by other aspects such as the expected (extrinsic) outcome of
learning, the perceived difficulty or prejudices towards the ‘typical’ teachers’ of these
subjects. Thus, there can be a wide divergence between students’ estimates of domain and
subject interest.

The construction of a theoretically satisfactory interest measure requires a
specification of the interest construct or a particular aspect of this construct that is used as a
basis for operationalisation. If the aim is, for example, to measure students’ domain interest
under consideration of the above-mentioned definition criteria explicated in the person-object-
theory of interest, the items of a questionnaire would have to take into account
cognitive/epistemic (‘wanting to know more’), emotional (‘enjoy’) and value-related
(‘considered to be important’) facets of the interest construct. An instrument that has been
developed on the basis of this theoretical concept is the Study Interest Questionnaire (SIQ;
Schiefele, Krapp, Wild, & Winteler, 1993) which may be applied to all kinds of subjects taught at secondary school or university, including scientific domains.

In PISA 2006, students’ general interest in science is measured in the student questionnaire (Q21) by eight multiple-choice items asking students how much interest they have in learning about the following broad science topics: physics, chemistry, biology of plants, human biology, astronomy, geology, the ways scientists design experiments and what is required for scientific explanations. The degree of interest is indicated by the categories high, medium, low, and no interest. Thus, the data from the student questionnaire do not specify the theoretically postulated cognitive and affective subcategories of the interest construct (see above).

**Methods for Assessing the Topological Structure of a Domain Interest**

Science interest is measured in a rather general way in other research approaches as well. Scores derived from statements in questionnaires or rating scales are used as an empirical indicator of the ‘amount’ or ‘degree’ of interest in a particular subject or domain. This methodical approach does not take into account that students’ interest is not equally high for all topics or activities related to a particular subject or domain. In order to reconstruct the content structure of science interest more precisely, a multidimensional concept of interest measurement is required (Gardner, 1996). One of the most differentiated instruments of this kind was developed within the framework of a longitudinal study on interest in physics (Haeussler, 1987; Haeussler & Hoffmann, 2000). As mentioned above, the construction of the questionnaire was based on a three-dimensional model. Each of the three dimensions (topics, contexts, activities) was further broken down into subcategories which resulted in a relatively complex overall model with eight content categories, seven context areas and four kinds of activities. The questionnaire consists of a total of 88 items. The hypothetical structure of interest in physics could essentially be confirmed in factor analyses carried out with the data from cross-sectional and longitudinal studies.
The international comparative study titled ‘The Relevance of Science Education’ (ROSE) on the attitudes and interest of secondary-level students in the area of science and technology (Schreiner & Sjøberg, 2004; see below) is also based on a multidimensional instrument which takes both a series of scientific subject areas and a large number of contexts into consideration. The questionnaire consists of 250 items which are answered on a four-point Likert scale. The questionnaire has been implemented in 40 countries up until now (Osborne & Dillon, 2008; Schreiner & Sjøberg, 2004). In both cases the specific subareas of students’ science interest in a particular domain are being measured retrospectively. Students are asked about their interest in a situation in which they are not directly involved with specific tasks or topics.

In this respect PISA 2006 has implemented a new and innovative measurement procedure, the so called ‘embedded’ approach for the assessment of students’ ‘interest in learning science topics’ (McCrae, 2009; OECD, 2006a; see Carstensen, Drechsel, & Prenzel, this volume). Eighteen out of 37 science units included a set of three items assessing students’ topic-specific interest in science. As the stimulus text (including pictures or graphs) of the cognitive task introduced the students to a specific context as well as a specific content area, the added interest items were related to concrete instances of context and content. In this sense, the interest assessment was contextualised in a way similar to the IPN interest study.

The main focus of this interest measure was on the cognitive (epistemic) component of science interest. The embedded items requested students to estimate their interest with respect to the categories ‘knowing more’, ‘learning more’, and ‘understanding better’. Other theoretically postulated characteristics referring to feeling- and value-related valences (see above) are not taken into account in this measurement procedure.

**Further Methods for Assessing Interest**

In survey studies such as PISA only a limited range of interest measures is applicable. The following hints may give an impression about methods used in other important research
approaches about the role of interest in teaching and learning.

Research approaches that aim at analysing the conditions or effects of interest-based learning at the level of states and processes have to deal with the problem that observations or inquiries may interfere with the subjective experiences of the person involved. An approach frequently taken is the use of questionnaires or rating scales which are administered after a teaching-learning episode. As with all retrospective methods, it has to be taken into account that the interviewees normally will not be able to remember exactly the actual quality of their experience during the interest-related activity and that the results will thus be distorted. A decisive factor for such distortions is the amount of time elapsing between the activity and the administration of a questionnaire. However, retrospective estimations of motivational conditions which are carried out at the end of lessons have by all means been proven empirically sound and reliable in science education (e.g. Seidel, Prenzel, & Kobarg, 2005). This is especially the case when students retrospectively assess the frequency of concrete experiences (e.g. ‘During the last lesson ... I would have liked to find out more about the topic’).

There are several ways to measure interest-related processes during a learning activity. In experiments designed to analyse the role of topic in text-based learning, Schiefele (1996) asked students to make ratings of subjective experience dimensions at nominated points during a reading task. Working from a different theoretical perspective but again focusing on experiential states during learning activities, Shernoff, Csikszentmihalyi, Schneider and Shernoff (2003) have used the Experience-Sampling Method (ESM) to explore empirical relationships between concentration, situational interest, enjoyment and the flow experience. ESM is based on the principle of time samples: In natural or experimental situations subjects are asked to work on a few questions or rating scales (e.g. about their current activities or the quality of their feelings) in close time proximity to a randomly assigned signal (Larson & Csikszentmihalyi, 1983).
A similar method to measure experiential states associated with interest-based learning has been adopted by Ainley, Hidi and Berndorff (2002). In experimental studies about how individual and context factors contribute to topic interest and text learning, traditional self-report measures were combined with a novel interactive computerised method of recording cognitive and affective reactions to science and popular culture texts, monitoring their development in real time. Following participants’ signalling of how interesting they expected the texts on certain topics to be, each text was presented in a form that recorded students’ choices, affective responses and persistence with each text. Tracking these behavioural variables enables the examination of psychological processes that may mediate between arousal of interest and learning outcomes (Ainley & Hidi, 2002).

In research approaches which aim at a detailed analysis of intra-individual development processes, qualitative methods such as observations in natural settings, open-ended interviews, group discussions or content analyses of diaries and other documents which contain information about interest-related activities are being carried out. Browne and Ross (1991), for example, made naturalistic observations yielding evidence about kindergarten children’s early science interests.

Important aspects of science interest can sometimes be revealed by using indirect measures. Typical examples are procedures for assessing the relative weight of science interest in student populations or estimations of students’ general attitudes towards particular subjects on the basis of data from official statistics (e.g. choice of courses in secondary school or majors in further education; Osborne et al., 2003).

A new possibility for analysing interest in certain populations is provided by databanks which can be used via the Internet. Baram-Tsabari and colleagues, for example, have carried out content analysis assessments of queries submitted to ‘Ask-A-Scientist’ sites in Israel, as well as of databanks of the Internet search engine Google which are accessible to the public in order to survey the content and focus of adolescents’ interest in the area of
science and technology (Baram-Tsabari & Segev, 2009; Baram-Tsabari, Sethi, Bry, & Yarden, 2006).

**Research Approaches and Relevant Findings on Students’ Interest in Science**

As interests in science are explored not only in science education but also in other disciplines (e.g. educational science, psychology, sociology), it is still a challenge to summarise the current state of research across topics and disciplines. In the following, we would like to give an impression of typical research approaches and findings by looking at some examples from central research questions that can be raised in any area of interest research and which are also relevant for the discussion of the findings presented in the following chapters of this special issue.

**How Domain Specific Are Interests in Science?**

Interest is a multidimensional construct that can be analysed and operationalised at different levels of generality and under consideration of different structural components of the interest concept. To which degree can we expect these components to be correlated? In everyday thinking it is often assumed that a general interest in science exists. Those who are highly interested in science (and technology) enjoy learning about any science-related topics and also like working with it outside of school.

Empirical research, however, provides evidence that this is a much too simplistic interpretation. In survey studies that use rather general indicators of both, interest in a school subject and enjoyment of learning mostly significant correlation are reported (Schutz & Pekrun, 2007). This also holds true for PISA 2006 (Ainley & Ainley, this volume). In his summary of psychological research about the interrelation of interest and emotion, Silvia comes to the conclusion ‘that interest and enjoyment are distinct positive emotions’ (Silvia, 2006, p. 29). When interest in science is explored in a differentiated manner, i.e. according to subject areas or specific topics, intra-individual as well as inter-individual distinctions are found (Haeussler Hoffmann, Langeheine, Rost, & Sievers, 1998; Ormerod & Duckworth,
1975; Osborne et al., 2003).

It has also been shown that subject interest or the relative popularity of a school subject does not facilitate a reliable statement about the corresponding domain interest, i.e. that part of interest which is concerned with the content questions and problems of a scientific domain or discipline. Although a relatively high correlation was found between domain and subject interest \((r=0.57)\) in the total sample of the Kiel study on interest in physics, this correlation varies considerably between the groups of students at different grade levels (Haeussler & Hoffmann, 2000; Hoffmann, Haeussler, & Lehrke, 1998). The same is true for the connection between domain and subject interest on the one hand, and corresponding interests in leisure time or professional interests on the other hand. Even within a certain scientific interest (e.g. in biology or physics), considerable differences have been found between the interest of individual students and student groups in the specific subject areas or topics of this subject.

**How High Are Students’ Interests in Science Compared to Other Subjects?**

Many empirical studies examine this question. Even though the details of the findings do not always concur, overall, they clearly indicate substantial differences between students’ reported interest in school subjects, which are often operationalised by comparative ratings of experienced or expected interestingness. While the subjects Physics and Chemistry, which are considered to be relatively difficult by the majority of students at the secondary level, are relatively unpopular and are rated as an interesting school subject comparatively seldom (Gardner, 1998; Hoffmann et al., 1998a), the subject biology has much higher scores when it comes to ratings of popularity and interest (Osborne et al., 2003; Tamir & Gardner, 1989). This is similar for the very heterogeneous school subject Geography (Geo Science; Trend, 2005). On the other hand, scientific topics and science subjects are very popular with elementary school students (Martin, Mullis, & Foy, 2008).

Subject-specific interest varies depending on how subtopics or the specific subject
areas of a subject are personally perceived. For example, in physics, topics which have a practical or social reference are rated as much more interesting than the general scientific principles of this subject (Haeussler & Hoffmann, 2000; Lavonen, Byman, Uitto, Juuti, & Meisalo, 2008).

**What is Known About Differences Between Subgroups?**

Surveys about the general level of interest (or other indicators of positive attitudes toward science) often try to identify substantial differences between particular subgroups of students that can be separated according to relevant educational or sociological variables such as gender, cultural background, geographic region, socioeconomic status of the families, etc. The PISA 2006 database also allows for exploring these kinds of questions (OECD, 2007).

**Gender differences** in scientific interest depend to a large degree on the domains. While interest in biology or the life sciences is just as pronounced in girls as in boys, if not more so, a different picture can be seen for the so-called ‘hard’ sciences. Physics and chemistry are subject areas in which girls usually show less interest than boys. The indications that girls turn away from the ‘hard’ sciences more so than boys over the course of their schooling are empirically well documented (Haeussler & Hoffmann, 2000; Jones, Howe, & Rua, 2000; Labudde, Herzog, Neuenschwander, Enrico, & Gerber, 2000).

Differences between what boys and girls consider to be interesting were also reported in ROSE (Osborne & Dillon, 2008; Schreiner & Sjøberg, 2004; Sjøberg & Schreiner, 2005) and in analyses based on PISA 2006 data (e.g. OECD, 2007).

Constructs such as self-concept and self-efficacy (Reis & Park, 2001; Zimmerman, 2000) play an important role in the explanation of gender-specific differences in interest in science. Gender-specific differences are mostly larger for self-concept than for self-efficacy (OECD, 2007), although high-performing girls also tend to underestimate their own ability compared to similarly high-performing boys.

Programmes for strengthening girls’ scientific interests thus often aim at the self-
concept of girls, and attempt to strengthen this with suitable tasks and feedback procedures (Haeussler & Hoffmann, 2002). Another successful strategy is a more careful recognition of girls’ topic interests in both science curricula and instruction. It has also been shown that a temporary separation of girls from boys in science classrooms can strengthen girls’ self-concept and interest. Other theoretical approaches suggest that the image of science and the interpretation of this image by peers play an important role in girls’ decision to turn away from science and technology in adolescence (Kessels, Rau, & Hannover, 2006). Here, too, it was possible to show that measures which change the students’ image of science and technology promote girls’ interest (Kessels & Hannover, 2007).

In the more recent international comparative studies of the [http://www.iea.nl/](http://www.iea.nl/) International Association for the Evaluation of Educational Achievement (IEA) and the Organisation for Economic Co-operation and Development (OECD), it can be seen that the differences between girls and boys both in the area of performance and that of interest are now only very small (Martin et al., 2008; OECD, 2007, 2009a). Overall, the effect strengths are low even when significant differences are observed. Similarly, no indications were found that boys and girls systematically differ in their expectations of having a future career which is related to science (and technology). The data gained in PISA 2006 seem to support this positive trend. Looking at all countries together (OECD, 2007), over two-thirds of students stated that they consider science to be important and useful, that they want to be good in science lessons and that they enjoy learning new things in these lessons. About 21% of students say that they will make science a central issue in their life; about 37% imagine working in a science-related career. Thus, a thoroughly positive picture of young people’s appreciation of science emerges worldwide. However, if one looks at the results of interest surveys at a country level, a noteworthy tendency can be observed: The interest in science is higher in less industrialised countries than in countries with advanced technological development. A similar picture can be seen in the Trends in International Mathematics and
Science Study (TIMSS) (Martin et al., 2008) and also in the ROSE study (Osborne & Dillon, 2008; Sjøberg & Schreiner, 2005).

**What Effect Does Interest Have on Learning in School and Educational Success?**

Research approaches that deal with this question interpret interest as an independent variable that can be used to predict the amount or the quality of learning motivation, students’ usage of learning strategies or academic achievement and other educationally relevant outcome variables (e.g. selection of an educational program or a professional career in a science domain).

Numerous studies have dealt with the correlation between interest, school grades and other indicators of school success in science and other subjects. The results have been summed up and reported in meta-analyses, amongst others, which consider indicators of interest alongside other affective and motivational factors (e.g. Willson, 1983). Schiefele, Krapp and Winteler (1992) carried out a meta-analysis of findings on the relationship between subject matter interest and academic achievement. Across all subjects and school levels, they calculated a mean correlation of $r=0.30$. The school subject is an important moderator: relatively high correlations were found for physics, science and mathematics. In the IPN study on interest in physics mentioned above, the subject interest in physics correlated with the corresponding school grade by $r=-0.38$ (Hoffmann et al., 1998a, p. 113). Sex-specific differences were not established. However, there are also studies in which no significant connection could be found between interest and school performance if the influence of other potential predictors is controlled (Köller, Baumert, & Schnabel, 2001). In PISA, weak correlations can also be observed between different measures of interest and performance (OECD, 2007). The relevance of interest for lifelong learning and choice of studies, however, does not depend on a high correlation between interest and performance. Both interest and performance are important educational aims. A low correlation can also indicate that students with a high cognitive potential for science do not pursue careers as scientists or engineers.
because they lost their interest during school.

How Does Interest Change Over the Course of Schooling and How Can the Development of Interest be Explained?

Although PISA 2006 does not provide data for exploring these kinds of developmental questions, we want to point in this concluding section to some exemplary findings in this area of interest research because they have a central position in the discussion about science interest (OECD 2006b; Osborne & Dillon, 2008; Roberts, 2002).

In the past years, educational interest research has looked, amongst other things, at the questions of whether there are general development trends, how these trends can be explained and how they can be influenced with suitable educational measures. The change in science-related interests over the course of schooling has been surveyed with different methods in many countries (Baumert & Köller, 1998; Daniels, 2008; Gardner, 1985; Osborne et al., 2003). Surveys at the secondary level are generally concerned with specific subjects or subject areas. Taken together, the data provide evidence that many students tend to lose their interest in science over the course of time. The ‘hard’ disciplines of physics and chemistry are particularly affected by this negative development. Biology is less affected, although considerable slumps can also be seen here at secondary level (Osborne et al., 2003). This decline is more pronounced in girls than in boys (Haeussler & Hoffmann, 1998).

The theoretical and practical relevance of such general development trends is often misjudged. They only provide information about changes in the average interest of a student population and cannot easily be used to describe or predict the most probable course of an individual’s interest development in this domain. This is due to the fact that the trend analyses are based on aggregated data and thus do not provide an insight into the course of interest development in specific subpopulations or particular subject areas of physics which deviate from this data. In fact, more exact analyses of the data available from longitudinal studies show that, realistically, very different developmental curves must be expected and that it is
not in any way justifiable to postulate a generally negative developmental trend in the domain
of science interests.

This can be demonstrated with the example of the Kiel study on interest in physics,
which combined a cross-sectional with a longitudinal study and accompanied more than 4000
students over a time span of six years (Grades 5 to 10; Haeussler et al., 1998; Haeussler &
Hoffmann, 2000). It was shown that the development of domain interest in different subject
areas (e.g. optical instruments, electricity and electronics, radioactivity) sometimes differs
considerably from the development of global domain interest (which is aggregated across all
sub-aspects). Furthermore, the findings indicate that there are only a relatively small number
of subject areas in which the interest of girls and boys differs largely (e.g. electricity and
electronics); in contrast, in the majority of specific factual interests, no serious gender-specific
differences can be identified. Domain interest remains largely constant over time in six areas.
In fact, interest in discussions on and evaluations of physics topics increases from the 9th to
the 10th grade. Furthermore, the analyses show that the developmental curves depend largely
on the way in which physics knowledge is integrated into a context. If physics instruction is
mainly aimed at presenting scientific natural laws and reconstructing mathematically, then the
majority of students--both boys and girls--lose interest in physics. In contrast, if physics
knowledge is taught in such a way that students can recognise a direct connection to practical
life situations in which they are personally interested, then there are good chances that their
interest will remain stable or even increase.

The findings from these more differentiated analyses are striking in that they show that
both the interest level and the course of interest development in science subjects depend
strongly on the perceived attractiveness of the prevalent curriculum’s lesson content on the
one hand, and on the other hand, on the manner in which scientific knowledge is presented
and taught. Against the background of these results, strong doubts are cast on the validity of
the statement that interest in science generally sinks dramatically at secondary level, which
can be found frequently in scientific literature.

**Future Prospects**

Interest is a central concept in science education. Schools must aim to promote interest in science and technology. On the one hand, this means supporting students’ open-mindedness towards science and technology. On the other hand, school makes a contribution towards clarifying interests. School helps students to discover which areas and topics they are enthusiastic about, which they would like to work on themselves, and in which they would like to get more involved—both in education and future professional life. In view of the high demand for new blood in science and technology, schools—as well as research institutes—have the task of making the importance of science and technology visible, as well as the intrinsic incentives and epistemic challenges of working in these areas.

Interest is also a key concept for science education in another respect: The interest that students effectively bring with them to school and further develop there is a decisive condition for instruction. It is the school’s task to pick up the interest which the students bring with them, i.e. to establish connections between it and the curricular requirements. These interests can relate to context, content and activities. Thus, an elaborate conception of interest and a diagnostic way of looking at things are important aspects of science teachers’ competency.

To a certain extent, the interests which students bring with them correspond to the ‘trait’ aspect of interest. In instruction, however, it is important to foster the ‘state’ aspect, i.e. situational interest. The repeated experience of situational interest in connection with scientific and technological topics, discursive models, experiments and their preparation and argumentative representation is the precondition for the development of a more stable interest which significantly influences the choice of courses, third level areas of study or careers.

Interest as a requirement of science education, as well as a means and aim of science education is thus, long after Herbart’s theory, still a serious challenge for our educational
institutions. As we have shown in this contribution, the theoretical conceptions of interest, its structure and the psychological functions on which it is based have been further differentiated since Herbart. In particular, they have been defined more precisely by empirical research in the last 50 years. As interest research also always has to consider the objects of interest (and their content), it relies on interdisciplinary approaches and cooperation. Accordingly, over the last decades, most advances in the examination of interest in science and technology can be found in the overlapping areas of science education, education and educational psychology. However, much more research remains to be done in these areas. What is particularly important here is to examine the conditions in science instruction, as well as in out-of-school environments, that support cognitive learning gains and performance, as well as those that stimulate and further develop interest in science and technology (Seidel & Shavelson, 2007).

Nowadays, international large-scale assessments provide a decisive impulse for the attention which the interest construct receives, as well as for further research on interests. Comparative studies which deal with science and mathematics have asked students about their attitudes towards science right from the beginning. However, the ‘interest construct’ was only considered indirectly, e.g. by surveying emotional aspects (enjoying science, having fun with science) or the value attached to individual school subjects or object areas. Sometimes, students were simply asked whether they were interested in science. Considering the differentiated and theoretically well-founded interest conceptions which were already available in educational psychology and science education at that point in time, these empirical approaches fell far short of the possibilities. Ultimately, this severely limited empirical survey clearly underestimated the significance of the interest construct (as a relevant aim of schools!). This situation was obviously changed by PISA 2006: In the survey’s framework, interest in science was considered to be an important aspect of scientific literacy. At the same time, an attempt was made to relate the interest concept to a structuring of science which systematically differentiated between contexts, content areas and
competencies. As a consequence of these considerations, an attempt was made to obtain a more differentiated picture by embedding an interest survey in the assessment. This approach can be understood as a first attempt by large-scale assessments to measure interest in a more differentiated way. This attempt had to be realised under the conditions of the very limited timescales of such surveys. Several contributions in this special issue provide an impression of the findings which have been gained with this approach.

It can be hoped that a starting point and a sustainable impulse for further efforts in the consideration of interest in large-scale assessments has thus been provided which will also have an influence on other areas (such as assessments concerning educational standards or the development of assessments for individual diagnostics). The development of computer-based assessments which provide exceptional possibilities for surveying facets of interest in more authentic situations would seem to be one particularly suitable approach. However, the development of such instruments also means a serious challenge for interest research.
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