Blankenburg, Janet Susan; Höffler, Tim Niclas; Parchmann, Ilka

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Fostering Today What is Needed Tomorrow: Investigating Students' Interest in Science

JANET SUSAN BLANKENBURG, TIM NICLAS HÖFFLER, ILKA PARCHMANN
Leibniz Institute for Science and Mathematics Education at Kiel University (IPN), 24118 Kiel, Germany

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ABSTRACT: This paper investigates the structure of German sixth-grade students' interest in science ($N = 474$; age 11–12 years) by considering different subject-related contexts (biology, chemistry, and physics) and different activities. Confirmatory factor analysis models were designed to validate the hypothetical structure of interest, connecting the whole spectrum of early school science with Holland's RIASEC model, and revealed that students' interest in science is best described by a cross-classified model with latent context and activity factors. Students were most interested in investigative and hands-on activities in all contexts. Despite the young age group, there were significant gender differences with regard to interest in contexts and interest in activities. For example, girls were more interested in *artistic* and *realistic* activities among most contexts and generally in the biological context. Surprisingly, boys were more interested in *social* physics activities than girls. This paper discusses implications for future research, for school science curricula as well as for how to engage students in science with particular emphasis on gender differences.
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INTRODUCTION

> "Leadership tomorrow depends on how we educate our students today — especially in science, technology, engineering and math." U.S. President Barack Obama, September 16, 2010

Correspondence to: Janet Susan Blankenburg; e-mail: blankenburg@ipn.uni-kiel.de

> "For Europe to become the world's most dynamic knowledge-based economy, the Union must, no doubt, address this shortage of scientific talent." Philippe Busquin, European Commission, April 2004

These quotations mirror the current political and educational discussion about science, technology, engineering, and mathematics (STEM) education in many industrialized nations. As numerous studies reveal, many young students are not interested in STEM fields as future professions for themselves (Archer et al., 2010; DeWitt et al., 2013; DeWitt, Archer, & Osborne, 2014; The Business-Higher Education Forum, 2011). Therefore, they do not pursue a college major in the STEM fields later on and thus do not work in STEM-related fields (Cleaves, 2005; Köller, Baumert, & Schnabel, 2001; Lindahl, 2003; Whalen & Shelley, 2010). As a result, serious staff shortages already hit the labor market and might endanger economic growth and contestability (European Commission, 2004; The Business-Higher Education Forum, 2011; The Royal Society, 2010). Thus, one major challenge and task for educational researchers is to get more students interested and skilled in science: "Ensuring that we will have such young people requires initiatives that engage students in interesting and motivating science experiences." (de Jong, Linn, & Zacharia, 2013, p. 305).

However, compared to cognitive aspects, affective variables of science learning currently seem to receive rather little attention[1] from both researchers and curricula (Fortus, 2014), as can be observed in the U.S. *Framework for K-12 Science Education* (National Research Council, 2012) and the *Next Generation Science Standards* (NGSS; National Research Council, 2013). Accordingly, the present article presumes that the major focus on cognitive variables is insufficient and warrants a deeper investigation of affective components of learning (for a review on emerging trends see Sinatra, Broughton, & Lombardi, 2014), especially interest (Su, Rounds, & Armstrong, 2009) starting in the early years of science education. Interest is an important predictor for secondary course choices and thus a premise for the further pursuit of science—not only as a career option but also as a decision guidance for citizens in a technologically driven world (Maltese & Tai, 2011; Tai, Liu, Maltese, & Fan, 2006; Tyson, Lee, Borman, & Hanson, 2007). Many studies show that elementary school students are generally highly interested in science and scientific activities (Dawson, 2000; Krapp & Prenzel, 2011). However, when they grow older many students lose their interest in science (Galton, 2009; Logan & Skamp, 2008; Osborne, Simon, & Collins, 2003). The transmission between elementary and secondary education seems to be of particular importance (Möller, 2014), as students get more science lessons and explanations become more abstract and complex.

To encounter this age-related effect, various interventions have been conducted that aimed to foster students' affective attitudes toward science in and out of school. For school curricula, for instance, a better relation between the content of science classes and the students' daily life as well as prospective future activities have been required, which led to approaches such as context-based learning (Nentwig & Waddington, 2005), science, technology, and society (Bennett, Hogarth, & Lubben, 2003), or socioscientific issues (SSI, Kolstø, 2001; Zeidler, Sadler, Simmons, & Howes, 2005). Moreover, inquiry-based learning has often been pointed out to raise students' interest (Hofstein & Lunetta, 2004; Potvin & Hasni, 2014). In addition to science classes at school, students can get involved with science through science fairs, science festivals, or science centers. In summary, main attempts to foster and sustain students' interest in learning science seem to be changes in

[1]With a number of notable exceptions, for example on the role of topic emotions in science learning (Lombardi & Sinatra, 2014), on the relation between confusion and science learning (D'Mello, Lehman, Pekrun, & Graesser, 2014), or on the relation between engagement, interest, and learning (Renninger & Bachrach, 2015).

the curriculum and the way of teaching science (Krajcik, Czerniak, & Berger, 2002; Swarat, Ortony, & Revelle, 2012), enrichment programs (Campbell, 2002; Stake & Mares, 2001), and extracurricular activities (Feldman & Matjasko, 2005). However, reported long-term effects were mostly small or even absent when systematically supervised (e.g., Bazler, Spokane, Ballard, & Fugate, 1993; Harwood & McMahon, 1997; Stake & Mares, 2001).

Yet, some studies show that the loss of a positive attitude/interest to learn science is not necessarily an inevitable development (e.g., Bennett, Lubben, & Hampden-Thompson, 2013). The "democratic schools" in Israel (Vedder-Weiss & Fortus, 2011) are one example. The key to success in these schools seems to be that students are strengthened in their perceived autonomy by the possibility to freely choose their subjects according to their own interests and the absence of controls and external rewards. For traditional schools approaches have been suggested, which also aim to foster students' autonomy by context-based learning, referring to the theory and findings of Deci and Ryan's self-determination theory (SDT; Ryan & Deci, 2000). SDT states that social contexts that support satisfaction of basic psychological needs (competence, relatedness, and autonomy) maintain or enhance intrinsic motivation. To design curricula or enrichment measures that offer a variety of activities connecting to students' interest in science, however, it is important to precisely characterize this structure of interests first.

For characterizing students' interest in physics, Häußler and Hoffmann (1998, 2000, 2002) proposed a three-dimensional structure, taking subject matter and context as well as school activities into account. Likewise, when investigating the effects of instructional episodes on students' interest in biology, Swarat et al. (2012) proposed three dimensions: content topic, goal of learning, and school activities, with only school activities having major influence on students' interest. Activities as characterizing attributes seem to be a valuable source of information, since these are crucial for interest development (Bergin, 1999; Palmer, 2009). The spectrum of activities and areas of nowadays science, both at school and out of school, has changed due to changes in curriculum emphases and to the broad spectrum of measures mentioned above. Learning science is no longer focusing primarily on the content and concepts, but also on different activities such as developing and evaluating scientific evidence or discussing SSI (OECD, 2007). Keeping these thoughts in mind, our study aims to get a more complex characterization of students' interests in science and science activities, and to lay an empirical basis for designing long-term effective curricula and extracurricular programs that foster and sustain students' interest in science. The series of instruments developed and tested in this and related projects can be used as formative measures to investigate the development of students' interest over time and in school as well as out of school settings (Dierks, Höffler, Blankenburg, Peters, & Parchmann, 2015). The present paper will present and discuss the instrument developed for introductory science classes at the early stage of secondary education.

THEORETICAL BACKGROUND

Although there are various definitions and theories, interest is commonly defined as a multidimensional construct with both cognitive and affective facets (Gardner, 1998; Krapp & Prenzel, 2011; Renninger & Hidi, 2011). The "person-object theory of interest" (Krapp, 2002a, 2002b) describes interest as a dynamic relation between a person and an object. Hence, interest is a content-specific construct (Schiefele, 2009) and always related to an object, topic, subject, activity, or idea.

Regarding stability of interest in the context of learning, individual and situational interest can be differentiated. While individual interest describes a relatively stable, long-term predisposition (Hidi & Renninger, 2006; Krapp, 2000), situational interest is prompted by features of a specific learning situation (Hidi, 2006; Schraw & Lehman, 2001). Thus, situational interest is a short-term emotional state, which is connected to the engagement with the object of interest. Despite the time restriction, situational interest can be the starting point for long-term interest development (Krapp, 1998, 2002a) in a specific domain.

Many studies have shown the positive impact of interest on learning. As one of the most important motivational variables, interest has significant impact on achievement (Bybee & McCrae, 2011; Papanastasiou & Zembylas, 2004) and leads to higher cognitive functioning and focused attention (Ainley, Hidi, & Berndorff, 2002; Hidi, 1990; Schiefele, 1999). Furthermore, interest is among other variables a significant predictor for choice of secondary courses which may lead to university majors (Bøe, 2012; Bøe & Henriksen, 2013; Köller, Daniels, Schnabel, & Baumert, 2000; Mujtaba & Reiss, 2013a).

In the field of education, science interest can be divided into two groups: interest in one or a combination of several science-related school subjects and interest in the general content area with an accumulation of topics, contexts, or activities (Krapp & Prenzel, 2011). Häußler (1987) and Häußler and Hoffmann (1998, 2000, 2002) took the dimensionality of interest in physics as a content area into account by differentiating three dimensions with several subcategories: subject matter, context, and school activity. Those elements were derived from their curricular model of physics education (Häußler, Frey, Hoffmann, Rost, & Spada, 1980). Following their line of argumentation, we further differentiate the analysis of interest in science based on a four-dimensional construct:

1. Interest in a particular domain (e.g., chemistry).
2. Interest in a particular subject matter or topic in a domain (e.g., combustion).
3. Interest in a particular context, which is embedded in a topic (e.g., combustion in everyday situations such as burning a candle).
4. Interest in a particular activity that is connected to the context and therefore to the topic (e.g., investigating the burning of a candle).

A well-investigated dimension is interest in different science topics (which are of course always embedded into a domain). Baram-Tsabari and Yarden (2005) inquired self-generated scientific questions Israeli children submitted to a TV program. The mainly young children (ages 9-12 years) were mostly interested in topics of biology (especially zoology), technology (especially computers and the internet), and astrophysics (especially size and distance questions).

The international large-scale study Relevance of Science Education (ROSE, Schreiner, 2006; Schreiner & Sjøberg, 2007) investigated 15-year-olds' experiences in and attitudes toward science in 34 countries. The results showed that the participants generally have positive attitudes toward science but with a clear incline of interest in science between rich and developing countries in favor of the latter and a more skeptical mindset of the former. This trend can also be seen in the rating of science topics as highly interesting by students from developing countries. The ROSE study, like many other studies, also reported gender differences regarding interest in science topics (Beaton et al., 1996; Dawson, 2000; Hoffmann, Häußler, & Lehrke, 1998; Jones, Howe, & Rua, 2000; Schreiner & Sjøberg, 2007); while girls are generally more interested in the human body, diseases, and health aspects, boys prefer topics such as technology, space travel, and scientific weapons.

The international Science and Scientists study (SAS, Sjøberg, 2002) is the antecedent of the ROSE study and focused on 13-year olds ($N = 9{,}350$). Both studies analyzed students' interest in science by comparing interest in different contexts belonging to the same topic. Thus, it was possible to identify typical "male" and "female" contexts. For example, the topic "science and society" was embedded into the context "How science and technology may help us to get a better life", which was rated more interesting by boys than girls, while "How science and technology may help disabled persons (deaf, blind, physically handicapped etc.)" was more interesting for girls (Sjøberg, 2002, p. 62).

Since activities have been proven to be important when developing interest, especially in science (Bergin, 1999; Palmer, 2009) more and more researchers investigate interest in activities, for instance Dawson (2000) for science, Swarat et al. (2012) for biology, Häußler and Hoffmann (2000) for physics, and Gräber (1992) for chemistry. Dawson (2000) examined interest in science topics as well as interest in science school activities (with separate items) by questioning Australian seventh graders in 1980 and 1997. The activities were structured into five categories: copying, informing, creative, active, and audiovisual. All students rated active and creative activities more interesting in 1997 than in 1980 with a simultaneous decrease in interest in more passive activities such as copying or receiving information. While Dawson (2000) used separate items to examine interest in science topics and science activities, Häußler (1987) and Häußler and Hoffmann (2000) took an integrated approach to students' interest in physics and concluded that the students' responses were primarily affected by the context and not the specific activity the items were describing. As opposed to this, Swarat et al. (2012) identified the dimension "activity" as having major influence in sixth- and seventh-grade students' interest in biology learning environment elements. In their study, 533 participants rated instructional episodes, which combined a content topic, a school activity, and a learning goal, for example, "ecosystems," "design/conduct investigation without scientific instruments or interactive technology," and "societal impact" (p. 521). An exemplary item was "Look at real data on polar bears to see if global warming is hurting the ecosystem at the North Pole" (p. 521). The researchers chose four biology content topics to avoid confounding with a lack of interest in different domains. Interestingly, the content topics were not distinguishable and formed one general factor that the authors believed to be either interest in biology or science in general. Hence, their quantitative results did not show significant influence of the content topic on students' interest in the instructional episodes. The primary influence on students' interests had the type of activity of which the authors identified three: hands-on, purely cognitive, and technology-connected activities. Gender differences were reported for hands-on and purely cognitive activities with higher values for female students.

Regarding these contradictory results, we state a demand for systematic investigations of students' interest based on models analyzing the influences of different dimensions. Several studies have only investigated single dimensions, such as subject matter or context. The effect of several dimensions on interest in science, however, has rarely been investigated in an integrated way. In addition, the broad spectrum of school and out of school science activities, including not only rather typical elements such as carrying out experiments but also social or socioscientific elements such as applying science knowledge to help others, is hardly represented by measures and instruments so far.

A systematic categorization of science activity types to examine their influence is missing, in our opinion. A closer look at the operationalization of science activities used in Häußler and Hoffmann's (2000) and Swarat et al.'s (2012) studies shows that both author groups used different, hardly comparable approaches with three or four rather broad categories. To investigate the influence of science activities on students' interest systematically and to answer the question whether the activity might be even more influencing than other dimensions such as the context, a more fine-grained and profound model seems necessary.

A systematic model recently used to investigate students' interest in school science activities is based on the heuristic model of interest proposed by Todt and Schreiber (1998), as well as Holland's "RIASEC" model (1997), which was originally designed for vocational choices. In this model, students' attitudes, abilities, values, and especially

TABLE 1
RIASEC Facets with Corresponding Attributes, Exemplary Activities, and Occupations (adapted from Holland, 1963, 1997)

RIASEC Facets	Attributes	Typical Activities	Exemplary Occupations
Realistic	Technically adept	Work manually, use machines	Carpenter, mechanic
Investigative	Analytic, task oriented	Analyze, learn, read, calculate	Scientist, researcher
Artistic	Creative	Find unusual ideas, draw, create	Musician, actor
Social	Sociable, caring	Teach, nurse, take care	Nurse, teacher
Enterprising	Leading, guiding	Lead, organize, control finances	Manager, politician
Conventional	Conforming, precise	Control, tabulate, follow instructions	Secretary, clerk

interests are categorized into six different personality types: *realistic* (R), *investigative* (I), *artistic* (A), *social* (S), *enterprising* (E), and *conventional* (C). The *realistic* personality type is a person who is technically adept and likes to work manually and/or to use machines. *Investigative* persons are very analytic and prefer activities such as analyzing, reading, and calculating. Persons who are the *artistic* type are supposed to be creative and therefore often like to draw or to create things. They are also creative in the sense of developing unusual ideas. *Social* personality types are caring and sociable and therefore prefer activities such as teaching and taking care of other people. *Enterprising* persons are interested in leading and guiding as well as taking control of finances. Persons who are categorized as *conventional* are conforming and very precise, for example, in structuring data into tables. This categorization according to the RIASEC facets enables a comparison with analogously rated occupations (Table 1), which is supposed to lead to a person-employment-congruency and thus to high performance and job satisfaction.

Although the model seems to employ stereotypes and people are, of course, generally more multifaceted, it was and still is used for vocational counseling (US: Strong Interest Inventory®, National Center for O*NET Development; Germany: Fux, Stoll, Bergmann, Eder, & Hell, 2002) and to assess (also young) students' interest in vocational activities (Lubinski, Benbow, & Ryan, 1995; Schmidt, Lubinski, & Benbow, 1998; Sparfeldt, 2007). Schmidt et al. (1998), for example, discovered that gifted 13-year-old female students are especially interested in *investigative* and *artistic* activities, whereas gifted male students are especially interested in *realistic* and *investigative* occupational activities. Although it is questionable whether students at that young age have already made final vocational choices, the study does give some hints about young students' interests. Nevertheless, it is exactly this narrow occupational focus that limits the RIASEC model to career counseling even though the personality types could be a valuable means for characterizing students' interests in (school) science activities. The multifaceted structure would give a more systematic insight into students' interests and therefore might not only shift the focus of research on students' interest in science to activity types but might also have consequences for curricula, the way of teaching, and the design of extracurricular activities. Thus, it would be possible to gain information regarding the effective design of curricula, education, and supportive measures suitable for further interest development as well as maintenance. Several studies reported, for instance, that girls rate social aspects in science as important (Baker & Leary, 1995; Jones et al., 2000; Potvin & Hasni, 2014). Such results could be taken into account by giving students the opportunity to choose from different RIASEC activities and thereby enabling autonomic choices (Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008). In addition to that, applying the RIASEC model could facilitate the transition to the labor market later on as the personality types are designed to guide career decisions.

Because of the promising structure on the one hand but the too narrow focus on science-related activities on the other hand, Dierks, Höffler, and Parchmann (2014) and Dierks et al. (2015) adapted the RIASEC model for school and out of school science activities. They investigated structures of interest of German secondary school students who took part in a science competition and those who did not ($N = 438$; Grades 7–10) and were able to describe students' interests satisfactorily based on the adapted RIASEC model. A new component was added due to the results of factor analyses, called *networking*, which describes interest in cooperative activities. Hence, the model has been enlarged to "RIASEC + N." With regard to gender differences, the authors found boys to have significantly higher interest in a combination of *investigative* and *artistic* school activities, while girls were significantly more interested in *realistic* school activities.

Dierks et al. (2015) also applied the adapted RIASEC + N model to assess interest in science activities in different environments (school, enrichment, and vocation) of students in Grades 8–12 and found significant differences with respect to gender and environments. Girls were significantly more interested in *realistic*, *artistic*, and *social* school activities than boys. In contrast, boys were significantly more interested in *realistic* vocational activities than girls.

By comparing the operationalization of school science activities used in different studies, it becomes obvious that the RIASEC + N model is more fine grained and therefore would be suitable to model students' interest in science activities in a more detailed and valid manner (Figure 1). For example, Häußler and Hoffmann's (2000) facet "A2 Learning by doing" sums up all the activities which Dierks et al. (2015) would categorize into either "*realistic*" (if guided by an instruction), "*investigative*" (if not guided by an instruction), or "*artistic*" (if a creative process is involved). Likewise, Swarat et al.'s (2012) dimension "Technology-based activities" can be subdivided into "*realistic*," "*investigative*", "*artistic*", or "*conventional*", considering that all those different activities can be supported by technology, but are not solely defined by it (Figure 1).

AIMS AND RESEARCH QUESTIONS

Using the findings of Dierks et al. (2015), we aimed to generate an instrument that could be used to examine interest structures of students at the very beginning of their secondary science education. Two dimensions seemed to be especially important for this investigation: interest in different facets of science-related activities and interest with regard to different contexts (embedded in a subject matter and a domain). Keeping in mind that most students develop their interest in and attitudes toward science before or in middle school (Maltese, Melki, & Wiebke, 2014; Maltese & Tai, 2010; Osborne & Dillon, 2008), we were especially interested in analyzing young students who had already experienced some science instruction (mainly biology and physics) in secondary school.

We applied the RIASEC + N model to gain a detailed insight into students' interest in science, especially with respect to interest in school science activities, by investigating the following research questions:

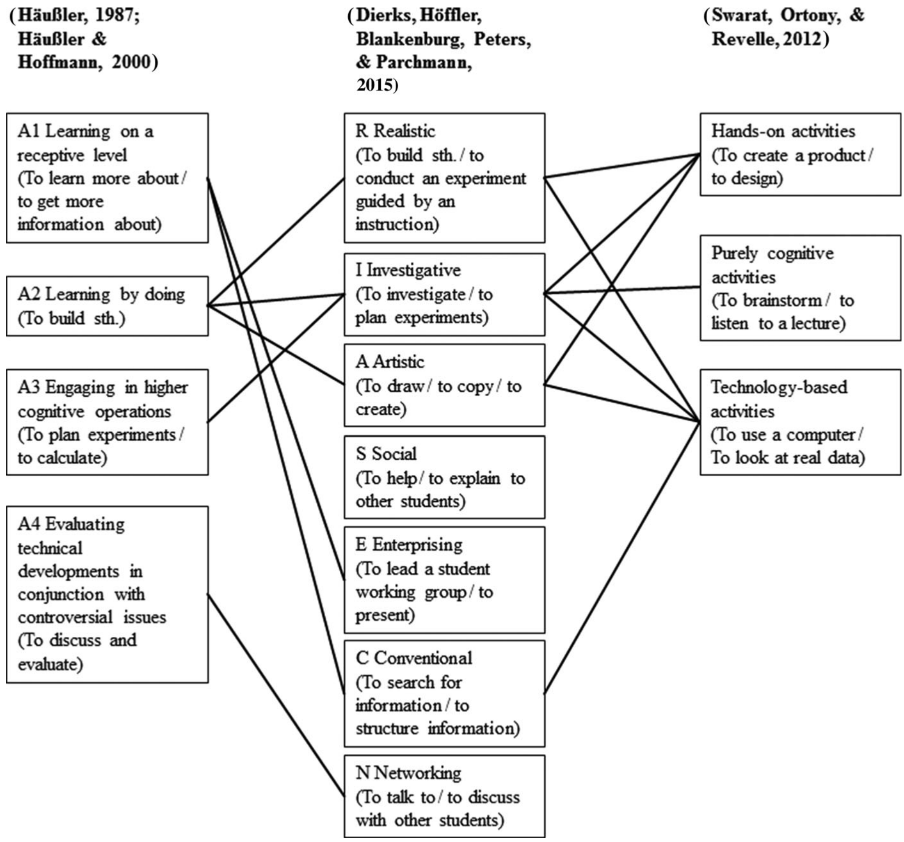

Figure 1. Comparison of the operationalization of "activity" in different studies.

1. To which extent is the adapted RIASEC + N model suited to measure students' interest in science as a combination of interest in a science context and interest in a school science activity? We expect that the model will indeed be applicable for the present study with younger students, based on positive experiences and results in former studies (Dierks et al., 2014).
2. How can the structure of interest in science activities be modeled? In which way do the two dimensions — context and activity type — interact? We assume that a multidimensional model will better explain the structure of interest than a one-dimensional model, considering the results of other interest studies.
3. Which RIASEC + N activities are students especially interested in? Are there differences with regard to activities? Dawson's (2000) studies in 1980 and 1997 pointed out that students' interests in science activities have changed. Active and creative activities were rated more interesting while passive activities were less attractive to the students. Hence, *realistic*, *investigative*, and *artistic* activities might be rated highest in our study.
4. Which gender differences can be detected?
   Many studies examined gender differences with regard to science topics and contexts. While boys are generally more interested in physics, girls prefer biology. Concerning activities, Swarat et al. (2012) reported girls to be more interested in hands-on and purely cognitive activities than boys. This corresponds mostly with the results

TABLE 2
Interest in Science: Chosen Aspects and Exemplary Items

Domain	Subject Matter	Context	RIASEC + N Facet (3 Items per Facet in Every Context)	Exemplary Item (from All Contexts; Translated; 21 per Context = 63 Items)
Biology	Flora and ecosystem	Plants	Realistic	Conduct experiments with plants guided by an instruction
			Investigative	Investigate the plants more closely
Chemistry	Combustion	Candles	Artistic	Draw a picture of a candle
			Social	Teach other students about the burning of candles
Physics	Buoyancy	Floating and sinking of objects (like ships)	Enterprising	Lead a student working group
			Conventional	Search for and organize information about objects that float or sink
			Networking	Talk with other students about objects that float or sink

of Dierks et al. (2014), who found that girls were significantly more interested in *realistic*, *artistic*, and *social* activities than boys. Therefore, we hypothesize to find gender differences with respect to contexts and activities. An interesting aspect might be the interaction of context and activity and the resulting interestingness ratings.

METHODS AND DESIGN

Design and Analysis Procedure

Instruments. In this study, we used an adapted version of the RIASEC + N instrument developed by Dierks et al. (2015), who used it to measure interest in school science activities in different environments (school, enrichment, and vocation).

Dierks et al.'s (2015) instrument was developed for older participants (around 15 years of age); hence, for our study, it was necessary to first facilitate the items linguistically. Each of the seven RIASEC + N activity facets was represented by three items, resulting in 21 items in total. In a second step, we adapted the items to (a) a biological (plants), (b) a chemical (candles), and (c) a physical context (floating and sinking) (Table 2), resulting in 63 items in total. The specific contexts were chosen in accordance with typical sixth-grade curricula, in agreement with science teachers, and with specific references to everyday life. The contexts have also been used in other studies successfully; those results might therefore give indications regarding validity. For example, the biology context "plants" was used by

Sjøberg (2002) and Dawson (2000) in a similar way. Their results show gender differences with higher ratings for girls.

Every context had a short introduction that described an everyday life situation and raised a question (e.g., "Why do ships float even though they are so heavy?"). Twenty-one items (with three items representing each of the seven facets, respectively, *realistic, investigative, artistic, social, enterprising, conventional, and networking*) followed each of the three contexts: *Realistic* items described hands-on activities guided by instruction so that the focus was on mere action rather than cognition. In contrast, *investigative* items referred to inquiry activities and thus also included cognitively demanding aspects. *Artistic* items involved creative aspects such as drawing pictures or designing posters. Items for the *social* facet included helping others by explaining content-related information and teaching fellow students. *Enterprising* items asked about interest in leading student working groups and organizing own projects. *Conventional* items described activities that involved searching for and structuring objects or information. Items of the *networking* facet referred to students communicating about certain topics at eye level (e.g., discussing).

As a result, 63 RIASEC + N items were included that had to be answered on a four-point rating scale (from "I am not interested at all in doing this/I would not like to do this" (1) to "I am very interested in doing this/I would like to do this" (4)).

A first version of the questionnaire was given to $N = 16$ students from sixth grade to validate the items' comprehensibility with cognitive pretesting (Karabenick et al., 2007). The students read the items out loud, explained their meaning, and declared which answer they would have given and why, using examples from their memories. After minor linguistic changes the questionnaire was tested in a pilot study with $N = 113$ sixth-grade students and was only slightly changed afterwards. The final questionnaire consisted of a total of 93 items including questions regarding gender, age, first language, and attended science classes as well as control variables such as academic self-concepts. Those additional variables do not form the main focus of this article and will therefore only be reported if they explain other findings.

Data Collection: Student Samples and Administration Procedure. The data were collected in six secondary schools (*Gymnasium*; the highest track of secondary schools in Germany) from five German federal states. The sample consisted of $N = 464$ students from 19 sixth-grade classrooms (45% female; age: $M = 11.90$ years, $SD = 0.42$). These schools were selected because they applied for a project to integrate science competitions into the school mission statement and were especially interested in investigating their students' interest in science to plan enrichment measures accordingly. The sample included both urban and rural schools. In Germany, science education starts systematically in the fifth grade. While it used to be differentiated into biology, physics, and chemistry as separate subjects (and usually still is between Grades 7 and 13), nowadays an integrated science instruction or a combination of science subjects (e.g., physics and biology) are taught in Grades 5 and 6 (Möller, 2014).

The study was conducted in August 2013 during regular lessons by instructed teachers. The students had sufficient time for filling in the questionnaire, which took about 25 minutes. As a reward for their efforts, each student got some sweets and a frisbee at the end of the session.

Data Analysis. Confirmatory factor analysis (CFA) models with a maximum likelihood estimator were used to analyze construct validity and therefore to answer the first research question whether the items are suitable to measure interest in school activities in scientific contexts (see Brunner, Nagy, & Wilhelm, 2012; Curran, West, & Finch, 1996; MacCallum & Austin, 2000). Mplus 5.2 (Muthén & Muthén, 1998) was used to calculate correlations and goodness-of-fit indices, which include the value of χ^2 (chi-square), *df* (number of degrees of freedom), the χ^2/df ratio (chi-square to number of degrees of freedom ratio), comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). Absolute-fit indices (such as χ^2, RMSEA, and SRMR) indicate directly how well the hypothesized model fits the data by comparing to a saturated model, that is, a model that perfectly replicates the observed covariance matrix. In contrast, incremental or comparative fit indices (such as CFI and TLI) measure the data fit by comparing the hypothesized model to an alternative, more restricted model (Hu & Bentler, 1998). For an excellent fit of the CFA model to the data and thus satisfying construct validity, both CFI and TLI values should be greater than .95. For the RMSEA, values close to .06 and for the SRMR values close to .08 indicate an acceptable to good fit, respectively (Hu & Bentler, 1998; Marsh et al., 2010). Furthermore, the χ^2/df ratio should take a value less than 2 (Schermelleh-Engel, Moosbrugger, & Müller, 2003). Different models can be compared to each other by comparing fit indices and calculating χ^2 differences. The values of the standardized factor loadings could clarify in which way the two dimensions — context and activity type — interact (second research question).

The third and fourth research questions directed the characteristics of students' interest in science school activities in different contexts, also with regard to gender differences. To answer those questions, independent *t*-tests were calculated with SPSS 19 after ensuring strict measurement invariance. Effect sizes were calculated using Cohen's *d* in the modified form of Hedges and Olkin (1985): the mean of one group was subtracted from the mean of the other group, divided by the pooled standard deviation (sometimes referred to as Hedges' *g*).

RESULTS

Preparation

The data were examined for normality assumption by inspecting the variable distribution for skewness and kurtosis. It met the assumption with absolute values of less than 1. Hence, the distribution of all variables was normal. The investigation of internal consistency as an estimate of reliability for all latent variables showed good to excellent Cronbach's alpha values ($\alpha = .72–.93$) after deleting one *realistic* item per context because of poor fit (Table 3).

CFA Models

To investigate whether the items are able to validly measure students' interest with regard to science contexts and science school activities, several theory-based CFA models were constructed and tested against each other. German students are used to science subjects being taught separately and not as a general science class. Thus, the first hypothesized model was constructed as a first-order factor model with three latent factors (biology, chemistry, and physics). Consequently, higher scores on the particular context factor are associated with higher scores on all scientific activities referring to that context. The interpretation of this model — if it fits — could either be that (1) the items are not able to measure students' interest in activities in a context or (2) students are interested in all activities in a certain context, as long they are interested in that context in general.

TABLE 3
Reliabilities and Descriptive Statistics

Scale	*n* Items	α	*M*	*SD*	M_{girls}	SD_{girls}	M_{boys}	SD_{boys}
Realistic	6[a]	.72	3.35	0.56	3.44	0.55	3.27	0.57
Investigative	9	.88	3.13	0.67	3.16	0.69	3.11	0.65
Artistic	9	.89	2.74	0.78	2.98	0.74	2.54	0.76
Social	9	.90	2.52	0.72	2.46	0.69	2.56	0.74
Enterprising	9	.88	2.66	0.74	2.65	0.75	2.66	0.74
Conventional	9	.90	2.70	0.74	2.77	0.75	2.64	0.73
Networking	9	.88	2.80	0.71	2.77	0.72	2.80	0.70
Biology (RIASEC + N)	20	.92	2.75	0.62	2.84	0.59	2.67	0.64
Chemistry (RIASEC + N)	20	.93	2.81	0.63	2.86	0.60	2.77	0.65
Physics (RIASEC + N)	20	.93	2.90	0.61	2.88	0.61	2.91	0.62

Note: [a]One *realistic* item per context was deleted because of poor fit. Higher values indicate higher interest.

By design, (a) each activity measure had a nonzero loading on one of the first-order context factors, but zero loadings on the other two; (b) the context factors were allowed to correlate; (c) context factor loadings were freely estimated and latent factor variances were constrained to 1 (Figure 2). The overall model fit of the context model proved to be poor as indicated by the goodness-of-fit indices ($\chi^2 = 2929.681$, $p < .001$, $df = 186$, $\chi^2/df = 15.751$, CFI = .663, TLI = .620, RMSEA = .179, SRMR = .094). The model fit indicates that the three context factors cannot adequately explain the associations among the activities, and therefore model parameters were not further investigated. Hence, either interest in a specific context did not explain interest in all school activities referring to that context or the items were not valid.

Second, a model with seven RIASEC + N activities first-order factors (*realistic*, *investigative*, *artistic*, *social*, *enterprising*, *conventional*, and *networking*) was constructed with the following characteristics: (a) each activity measure had a nonzero loading on one first-order RIASEC + N factor but zero loadings on the others; (b) correlations among the factors were allowed, and again, (c) factor loadings were freely estimated and factor variances were constrained to 1 (Figure 3). In this model, higher scores on a particular RIASEC + N facet are connected with higher scores on all activities related to that facet, independent of the context. Again, if the model fits, two interpretations are possible: (1) the items could only measure interest in activities but are not able to differentiate between contexts or (2) if students are interested in a specific type of school activity (e.g., *investigative* activities), they are interested in this certain activity type in all three scientific contexts. The resulting model showed a poor fit to the data ($\chi^2 = 2216.613$, $p < .001$, $df = 168$, $\chi^2/df = 13.599$, CFI = .749, TLI = .686, RMSEA = .163, SRMR = .072), which is why the model was not further investigated. Thus, either interest in a type of school activity did not explain interest in that activity in all science contexts or the items were not valid.

The third model was constructed to include both contexts and RIASEC + N facets. The CFA model is similar to models used for multitrait–multimethod analysis (Campbell & Fiske, 1959; Eid & Diener, 2006). We defined a cross-classified model with the following features: (a) each activity measure had a nonzero loading on the corresponding context factor (biology, chemistry, or physics) and zero loadings on the other two context factors; (b) each activity scale had a nonzero loading on the corresponding RIASEC + N factor and zero loadings on the other ones; (c) correlations between the context factors were

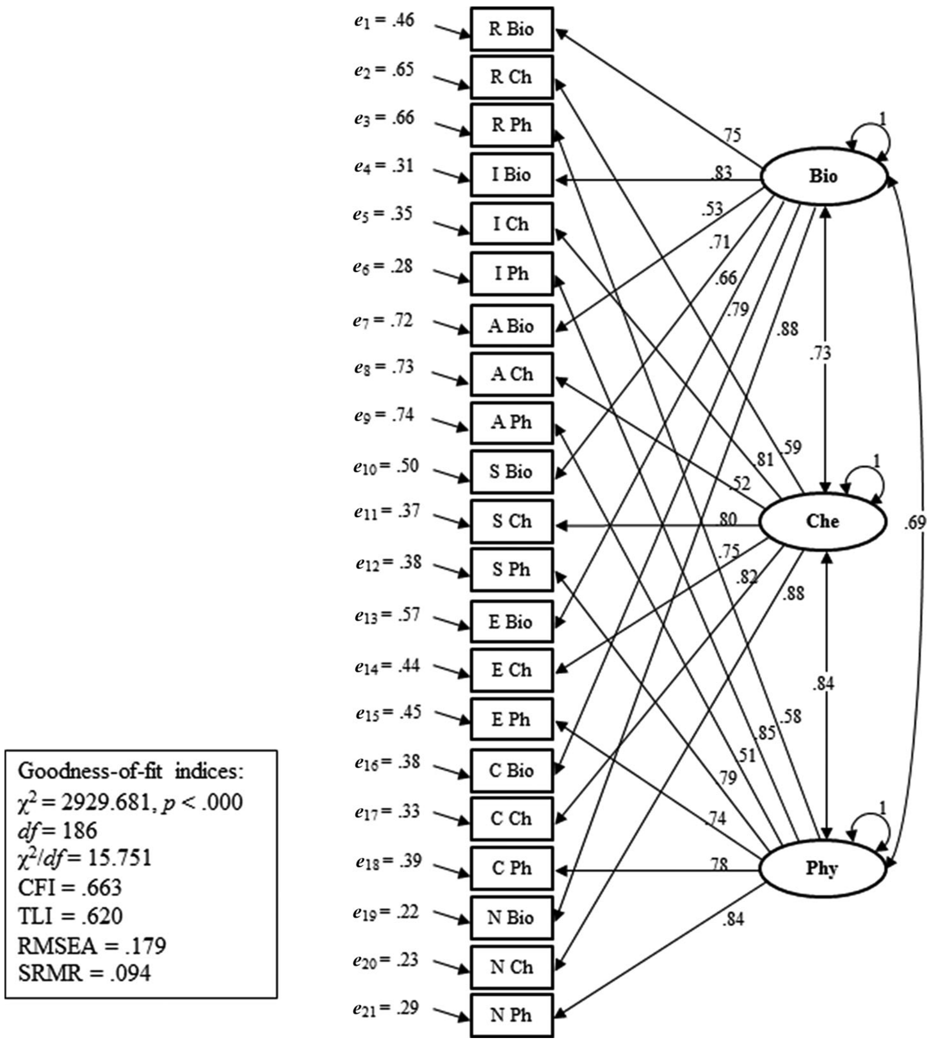

Figure 2. Context model for interest in science activities.

allowed as were correlations between the RIASEC + N factors, but (d) no correlations between context and RIASEC + N factors; and (e) factor loadings were freely estimated and factor variances were constrained to 1 (Figure 4). The cross-classified model fit the data very well ($\chi^2 = 181.158$, $p = .020$, $df = 144$, $\chi^2/df = 1.258$, CFI = .995, TLI = .993, RMSEA = .024, SRMR = .030). The CFI and TLI reached values near 1 and RMSEA and SRMR reached values less than .05. In comparison to the other two models, the superiority of the cross-classified model is obvious by mere goodness-of-fit indices (Table 4) and was additionally confirmed by χ^2 difference testing: cross-classified model versus context model: $\Delta\chi^2(42, N = 459) = 2748.523$, $p < .001$; cross-classified model versus RIASEC + N model: $\Delta\chi^2(24, N = 459) = 2035.455$, $p < .001$.

As a result of the good model fit, we can conclude that the instrument is sensitive to both context and activity types and therefore validly assesses students' interest structure with regard to science contexts and science school activities in this sample. Regarding the correlation between the context factors biology, chemistry, and physics, Figure 4 shows

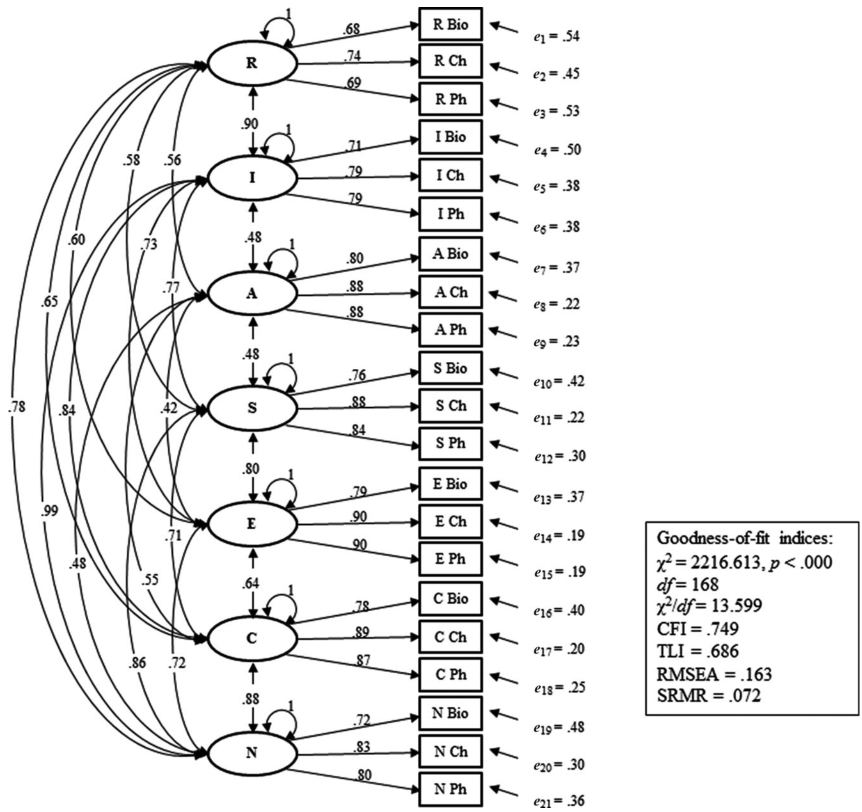

Figure 3. RIASEC + N model for interest in science activities.

TABLE 4
Goodness-of-Fit Indices for the Two First-Order Factor Models and the Cross-Classified Model to Describe the Structure of Interest in Science

Model	χ^2	*df*	χ^2/df	CFI	TLI	RMSEA	SRMR
Context model (3 factors)	2929.681***	186	15.751	.663	.620	.179	.094
RIASEC + N model (7 factors)	2216.613***	168	13.599	.749	.686	.163	.072
Cross-classified model (7 + 3 factors)	181.158*	144	1.258	.995	.993	.024	.030

**p* < .05, ****p* < .001: CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

that the correlation between physics and chemistry is higher ($r = .72$) than the correlations between biology and the other two factors (chemistry: $r = .56$; physics: $r = .55$). The correlations between the RIASEC + N factors vary from $r = .12$ to .77. As a next step, we analyzed the values of the standardized factor loadings (all of which were significant) for the subscales on both the context and RIASEC + N factors. For the contexts, the factor loadings ranged from $\lambda = .33$ (chemistry *realistic*) to $\lambda = .78$ (physics *investigative*) with

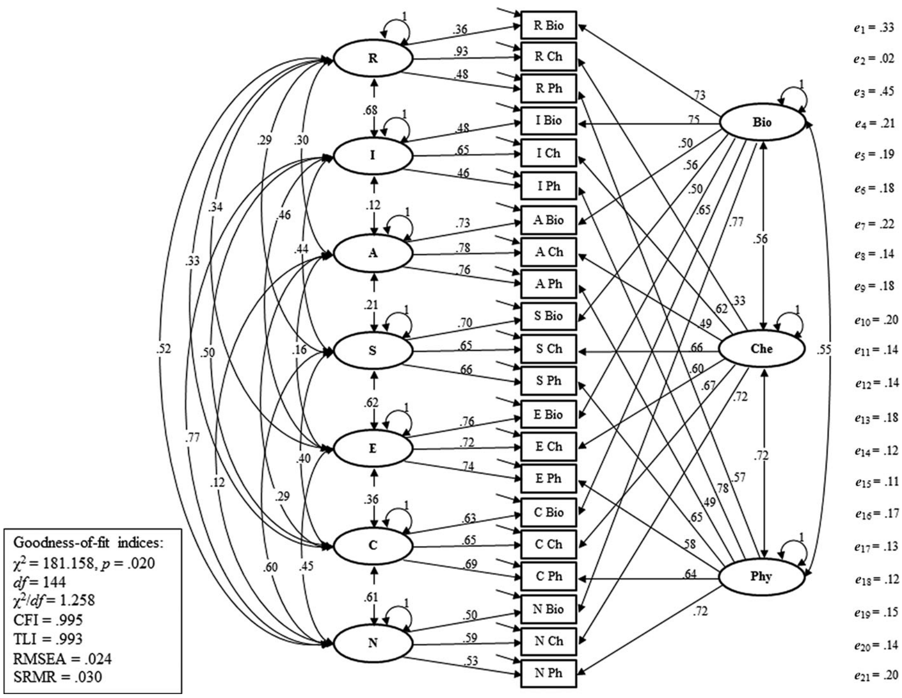

Figure 4. Cross-classified model for interest in science activities.

a median loading of *Mdn* $\lambda = .64$. This indicates that the latent context variables did have a strong effect on most activity subscales. Subsequently, higher interest in a certain science context leads to higher interest in all activities in that context. The factor loadings on the RIASEC + N factors varied from $\lambda = .36$ (biology *realistic*) to $\lambda = .93$ (chemistry *investigative*) with a median loading of *Mdn* $\lambda = .65$. Again, the latent variables had a strong effect on most subscales. Interest in a certain RIASEC + N activity type leads to higher interest in all activities connected to this type, regardless of the context (Figure 4).

Consequently, the second research question can be answered as follows: In this study, interest in both factors — context and activity — are equally important for students to rate the interestingness of the items. Thus, a multidimensional model best describes students' interest in science.

Interest in Science Activities

The third research question asked for activities students are interested in. Generally, the sixth-grade students were interested in activities in all three science contexts. Especially, the floating and sinking context (why do ships float despite their size and weight?) seemed to draw interest. Regarding the RIASEC + N activities, sixth-grade students rated *realistic* and *investigative* activities highest and *social* and *enterprising* activities lowest, independently of the context.

To answer the fourth research question regarding gender differences, group comparisons on several levels were made according to the cross-classified model. To compare girls and boys by analyzing manifest values (via *t*-tests), strict measurement invariance had to be ensured first. Thus, multiple-group confirmatory factor analyses were conducted to test

TABLE 5
Goodness-of-Fit Indices for Measurement Invariance

Multiple-Group Model	χ^2	*df*	χ^2/df	CFI	TLI	RMSEA	SRMR
Configural measurement invariance	348.559**	288	1.210	.992	.989	.031	.042
Metric/weak measurement invariance	420.774***	330	1.275	.989	.986	.035	.058
Scalar/strong measurement invariance	446.621***	341	1.310	.987	.984	.037	.064
Strict measurement invariance	501.621***	363	1.382	.983	.980	.041	.082

$^{**}p < .01$, $^{***}p < .001$: CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

whether the items measure the same theoretical construct across both groups (girls and boys) by the following consecutive steps (Wang & Wang, 2012):

1. Configural measurement invariance tests a multiple-group baseline model with the same number of factors and the same factor loading patterns across groups.
2. Metric/weak measurement invariance tests a multiple-group model with invariant factor loadings across groups.
3. Scalar/strong measurement invariance tests a multiple-group model with both invariant factor loadings and item intercepts across groups.
4. Strict measurement invariance tests a multiple-group model with invariant factor loadings, item intercepts, and error variances across groups.

Every step of measurement invariance adds more restrictions to the baseline model. Table 5 shows the consistently acceptable to good goodness-of-fit indices for all four models. For testing measurement invariance, the four models were compared. For this purpose, model evaluation by CFI difference testing has been proven superior to χ^2 difference testing. ΔCFI is not affected by sample size or model complexity (Cheung & Rensvold, 2002). "A value of ΔCFI smaller than or equal to –0.01 indicates that the null hypothesis of invariance should not be rejected" (Cheung & Rensvold, 2002, p. 251). Using this criterion, we could demonstrate strict measurement invariance, as ΔCFI was smaller than .01 between all consecutive models. Therefore, it was possible to compare manifest means across groups (Steinmetz, 2011).

As to students' interest in science school activities in different contexts (biology, chemistry, and physics), significant gender differences were only detected in the biology context. Overall, girls rated the activities in this context as more interesting than boys (Figure 5; $t(449) = 2.883$, $p < .01$, $d = 0.27$).

Following this significant difference, the biology context was further divided — according to the cross-classified model — into the RIASEC + N facets (Figure 6). This revealed significant gender differences in the *realistic* (hands-on guided by instruction), *artistic* (creative), and *conventional* (precise; search for and structure information) activities with higher values for girls (see also Table 3).

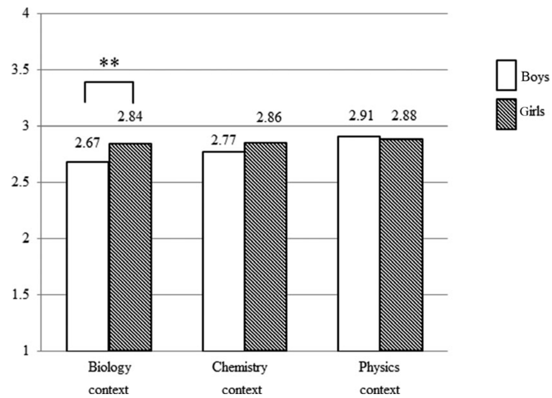

Figure 5. Interest in science school activities in three contexts (**$p < .01$).

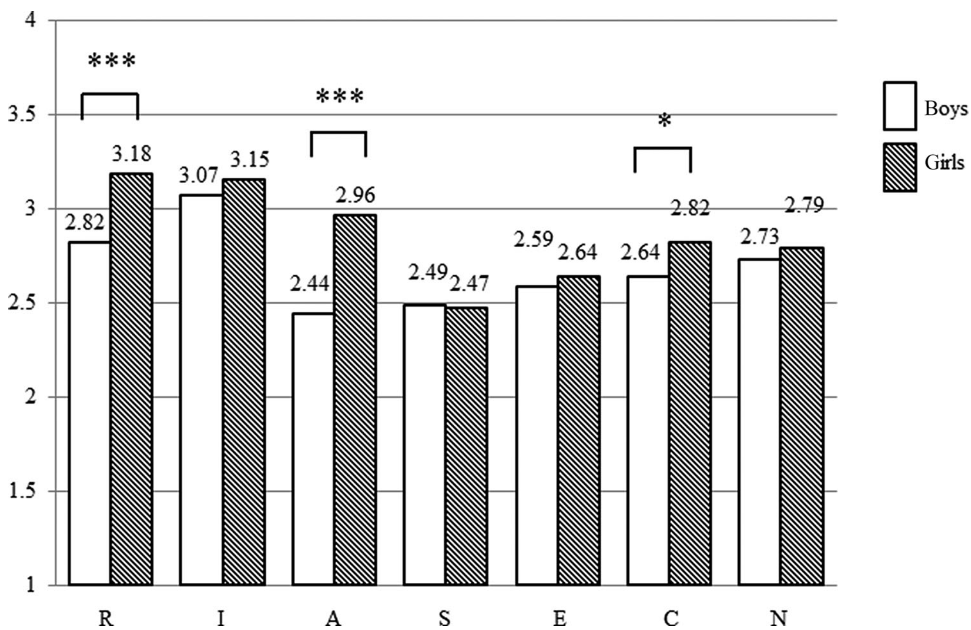

Figure 6. Interest in science school activities in the biology context: *realistic, investigative, artistic, social, enterprising, conventional,* and *networking* (*$p < .05$, ***$p < .001$).

Although no gender differences were found for the chemistry and physics contexts in general (Figure 4), the RIASEC + N facets again revealed a more detailed insight into students' interests (Figures 7 and 8; see also Table 6): girls were more interested in *artistic* activities in the physics and chemistry context as well as in *realistic* chemistry activities. Surprisingly, boys were more interested in *social* physics activities than girls.

Additional Variables

As to additional variables which were also measured, we found significant differences between boys' and girls' science self-concept ($M_{\text{girls}} = 2.86$, $SD_{\text{girls}} = 0.55$; $M_{\text{boys}} = 3.05$, $SD_{\text{boys}} = 0.56$; $t(462) = 3.59$, $p < .001$, $d = 0.34$).

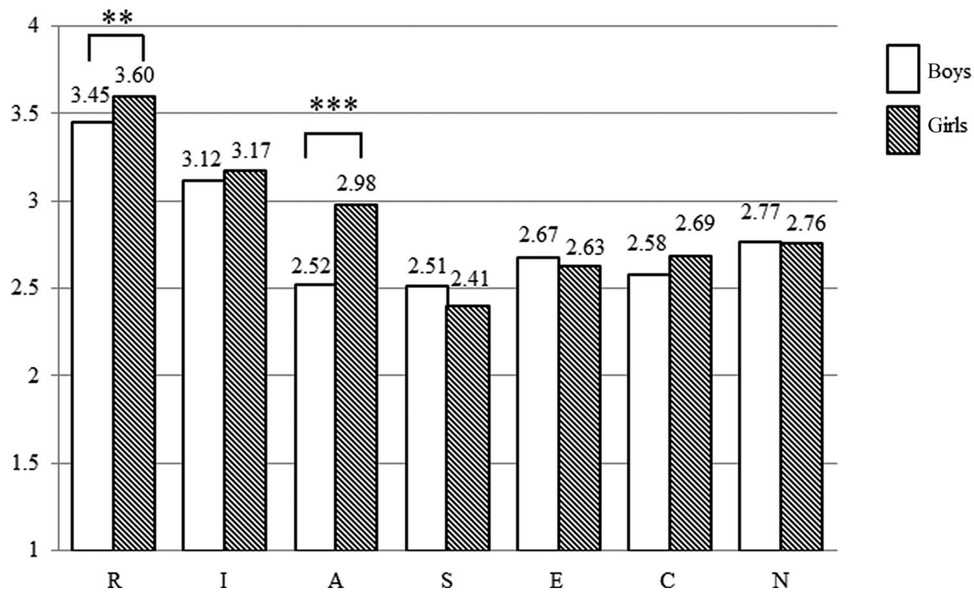

Figure 7. Interest in science school activities in the chemistry context: *realistic, investigative, artistic, social, enterprising, conventional,* and *networking* (**$p < .01$, ***$p < .001$).

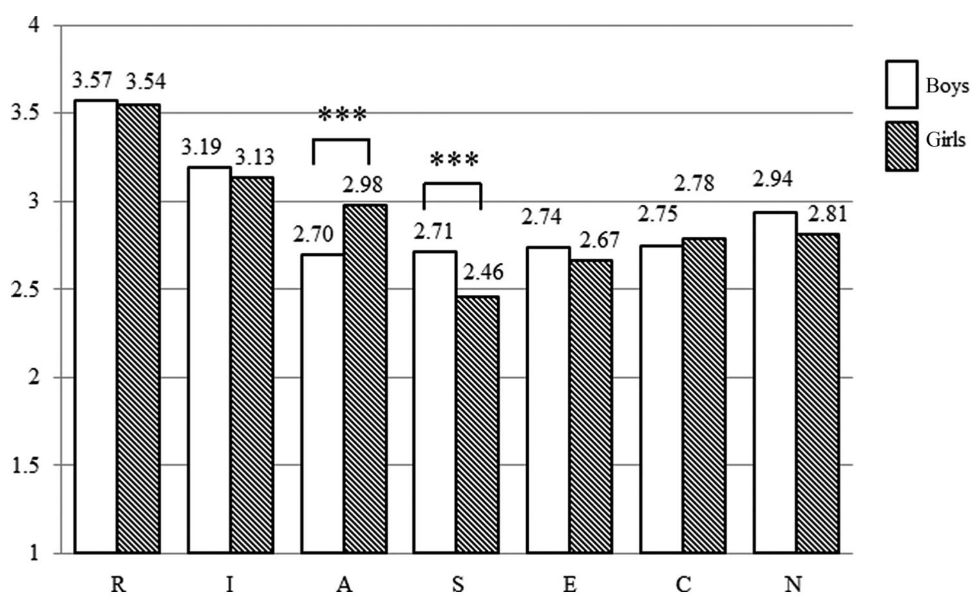

Figure 8. Interest in science school activities in the physics context: *realistic, investigative, artistic, social, enterprising, conventional,* and *networking* (***$p < .001$).

DISCUSSION AND CONCLUSION

The investigation of construct validity by theoretical CFA models showed that the instrument is suitable to measure students' interest in science as a combination of interest in a context and in an activity. A cross-classified model indicated that students with higher interest in a certain science context also have higher interest in all activities in that context.

TABLE 6
Significant *t*-Test Results for the Comparison of Girls and Boys

Scale (Context–Facet)	Group	*n*	*M*	*SD*	*p*	*d*
Biology–Realistic	Girls	203	3.18	0.73	.001	0.46
	Boys	244	2.82	0.84		
Biology–Artistic	Girls	203	2.96	0.80	.001	0.68
	Boys	244	2.44	0.86		
Biology–Conventional	Girls	203	2.82	0.79	.018	0.23
	Boys	244	2.64	0.82		
Chemistry–Realistic	Girls	201	3.60	0.54	.011	0.24
	Boys	242	3.45	0.67		
Chemistry–Artistic	Girls	201	2.98	0.80	.001	0.55
	Boys	242	2.52	0.86		
Physics–Artistic	Girls	202	2.98	0.81	.001	0.33
	Boys	244	2.70	0.87		
Physics–Social	Girls	202	2.46	0.79	.001	0.30
	Boys	244	2.71	0.85		

Higher values indicate higher interest.

Moreover, students who like to do certain RIASEC + N activities (e.g., *realistic* (R) activities) are more interested in all activities of this RIASEC + N facet (all *realistic* activities). Hence, this result implies that students are generally receptive to stimulation by both context and activity type. Thus, fostering and generalizing students' interest can be achieved by either addressing one's interest in a specific context or in a specific activity type.

We already know much about students' interest in different science contexts, also with regard to gender differences. In our study, the overall interest in activities in the three contexts was quite high. Especially the girls' unusual high interest in the physics context caught our attention. This might be the result of the connection to everyday objects like ships (Sjøberg, 1990) — even though everyday objects do not foster science interest per se, only because they have scientific compounds, for example, soap (Schreiner, 2006). Our intention was to find contexts that are representative for sixth-grade science curricula as well as meaningful and related to daily lives. The contexts were also used in other studies (Dawson, 2000; Schreiner & Sjøberg, 2004; Sjøberg, 2002), so that a comparison to these studies give some insights concerning reliability and validity. As for the biology context (plants), gender differences with higher interest of girls are well reported and could be replicated in this study. While the three contexts are typical representatives of their respective domain for this age group, the focus of this study was on interest in different *contexts*. With some caution, generalizations to domains are certainly possible, but no conclusive statements on interest in different domains can be made.

With regard to the study's other focus, interest in RIASEC + N facets, our results show that students were most interested in *realistic* and *investigative* activities in all three contexts. Girls rated *realistic* activities in the biology and chemistry contexts higher than boys. Those items described instruction-guided hands-on activities, which might support and encourage especially girls who are generally less inclined to take risks (Dweck, 2007; Jovanovic, Solano-Flores, & Shavelson, 1994). These results are supported by the findings of Swarat et al. (2012) stating that sixth- and seventh-grade girls are slightly more interested in hands-on activities than boys. Their definition of hands-on activities (to create a product/to design) resembles our *realistic* and *investigative* science school activities, which makes the girls' high interest in these activities — additionally, in their preferred contexts — not too surprising. Furthermore, Dierks et al. (2015) found a comparable effect for *realistic* science-related school activities in older students (about 15 years old). Nevertheless, this result is certainly unexpected and counterintuitive and therefore warrants further investigation.

Regarding our results on *social* activities, other studies show that girls rate social aspects of science as very important (Baker & Leary, 1995; Jones et al., 2000; Schreiner, 2006). In our study, however, girls rated *social* items quite low in all contexts. In the physics context, the boys even showed significantly higher interest in *social* activities. These findings seem to contradict each other, but might be explained by our item operationalization. In Holland's framework (1997), the *social* facet refers to helping as well as teaching other people. In our educational context of science school activities, on the other hand, we focused on teaching and helping in the sense of explaining. We assume that this content-related definition of *social* activities established a connection to constructs such as science self-concept, as students need to be confident in their own knowledge and skills to explain something to others (which are girls less so in science; see Wilkins, 2004). The same might apply for the low interest in *enterprising* activities (leading a student work group). The results for the science self-concept support this assumption as boys rated their science self-concept significantly higher than girls. Thus, girls might not feel competent enough to explain science topics to others. The results suggest that the boys' interest in *social* activities seems to be determined by their interest in the context. Typical "social" aspects of science have been reported as especially important for girls; those were covered by our instrument's facet *networking*, which reflected communicative elements. Again, further investigation is needed, especially regarding the *social* facet. While the explanation above might be true, the results could also be interpreted as a sign of inadequate validity of this facet — or, to be more precise, of various aspects of the term *social*.

Further significant (expected) interest gender differences occurred in *artistic* activities, such as drawing or designing with high mean values for the girls in all three contexts. While this result as such is not surprising, it provides a worthwhile possibility to foster and maintain girls' interest in science.

With regard to the broad spectrum of science activities required by standards and curricula such as the NGSS (National Research Council, 2013) or the *National Curriculum in England* (Department for Education, 2013), our instrument offers insights into students' interest structures in a more sophisticated and systematic way than other studies. A comprehensive characterization of students' interest in science school activities in connection to RIASEC + N personality types and future career choices might give the opportunity to foster and maintain students' interest permanently and to result in more students pursuing a college major in the STEM field.

The NGSS (National Research Council, 2013) define standards by three dimensions: practices of science and engineering, cross-cutting concepts, and disciplinary core ideas. Disciplinary core ideas describe — roughly speaking — the topics relevant to science teaching (e.g., "matter and its interactions"; "energy"). Cross-cutting concepts are those concepts that are relevant for all scientific domains, such as "patterns," "scale," and "energy and matter." The practices of science and engineering are the skills students develop in the course of inquiry learning. The NGSS name eight practices that are "based on an analysis of what professional scientists and engineers do" (National Research Council, 2013, appendix F, p. 2). Therefore, the practices could be described as activities that students should perform in science classes to develop those skills.

The *National Curriculum in England* (Department for Education, 2013) is divided into four key stages by segments of years. Key stage 1 contains the first 2 years of school (children aged 5–7), key stage 2 contains years 3–6 (aged 7–11), key stage 3 contains years

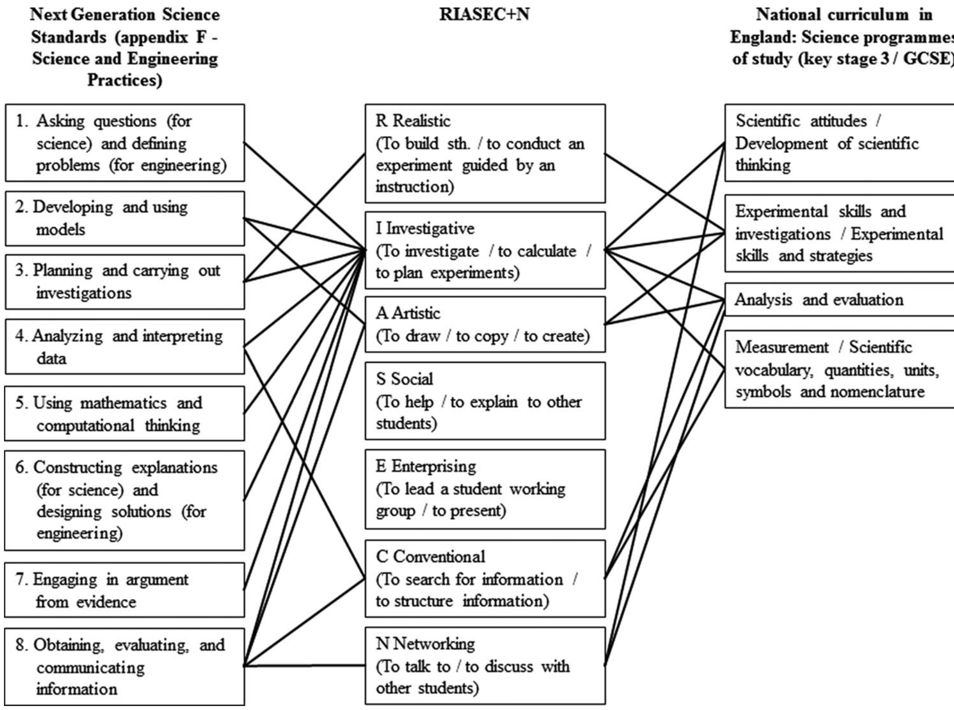

Figure 9. Parallels between the *Next Generation Science Standards* (National Research Council, 2013), the RIASEC + N model (Dierks et al., 2015), and the *National Curriculum in England: Science programmes of study* (Department for Education, 2013).

7–9 (aged 11–14), and key stage 4 contains years 10 and 11 (aged 14–16). The curriculum describes two main dimensions: (1) subject contents and key ideas and (2) aspects of "working scientifically." Those scientific methods describe the activities students should engage in to develop scientific skills.

A classification of the practices of the NGSS and the *National Curriculum in England* according to the science-adapted RIASEC + N facets shows most of them being represented. The NGSS, just like intended, show a clear focus on the *investigative* facet (Figure 9). This strong emphasis on *investigative* activities might have gender implications (Tracey, 2002). The *National Curriculum in England* for key stage 3 (age cohort of our study's participants) and the GCSE specification (as upper limit of qualification) focus on the *investigative* facet but tend to be evenly distributed. Interestingly, neither of the two concepts explicitly refers to *enterprising* or *social* activities.

The *German National Standards of Education* (*Nationale Bildungsstandards*) for scientific subjects are achievement standards. They describe the abilities that students should have gained at the end of lower secondary school (Grade 9 or 10). There are separated standards for biology, chemistry, and physics. For each subject the standards define three dimensions: areas of competence, basic concepts, and levels of competence. The areas of competence are subject knowledge, application of epistemological and methodological knowledge, communication, and judgement (Schecker & Parchmann, 2007). Science activities are incorporated into the latter three areas and can be classified according to the RIASEC + N facets. The *German National Standards of Education* especially focus on *realistic*, *investigative*, *conventional, and networking* activities. *Artistic, social*, and *enterprising* activities, on the other hand, seem to be hardly represented.

Our study using the science-specific RIASEC + N facets could show that both female and male sixth-grade students are interested in *realistic* and *investigative* school science activities after all. Thus, the NGSS, the *National Curriculum in England*, and the *German National Standards of Education* with their focus on inquiry-based learning have the potential to interest both boys and girls. However, when students grow older, their interest profiles change, generally. Hence, an interesting research aspect would be the development of students' interests in RIASEC + N science activities over time. To investigate if and how interests in science activities differentiate in the course of years might give hints as to students' low willingness to further engage in science both in school and in occupational life. As Dierks et al.'s (2015) results show, older students are more interested in *social* and *networking* activities than the participants of this study. This might be due to the transition from a more egocentric to a more social perspective. However, neither the NGSS, nor the *National Curriculum in England*, nor the *German National Standards of Education* explicitly mention *social* science activities.

A detailed analysis of students' interest in science activities, which also focuses on subgroups (girls vs. boys; different grades; participants of enrichment measures vs. non-participants), might give more information on possibilities to foster students by designing effective curricula and extracurricular activities. Structuring lessons according to topics and RIASEC + N activities could show students different facets of modern science and give them the opportunity to develop skills needed for their future work life.

Limitations of the Study

The data were collected in *Gymnasien* (highest track of secondary schools in Germany), which applied for a project to foster student competitions and are especially interested in planning science enrichment measures. On the one hand, this leads to a limited generalizability, whereas on the other hand, we investigated specifically those students who are going to gain a university entrance certificate after completing school. Therefore, they are the ones who might pursue a college major and a career in the STEM fields later on and are thus the most relevant group for our study.

The items in this study were constructed with reference to interest in (1) domains (biology, chemistry, and physics), (2) particular subject matters (e.g., combustion), (3) particular contexts (e.g., combustion in everyday situations such as a burning candle), and (4) particular RIASEC + N activities (e.g., investigating a burning candle). Since different domains were chosen to cover science in general, different subject matters had to be accepted that might cause limited generalizability — though Swarat et al. (2012) found that four different biology subject matters did not have heterogeneous effects on students' interests. While linking subject matters of all three domains (e.g., energy) might have been a possible way to keep the topic constant, unfortunately there is no common ground in German sixth-grade curricula. We therefore chose different subject matters and tried to link the items by the connection to everyday life situations and alternate RIASEC + N activities. A stricter control of variables as well as an extension of topics and context might be in order for future studies, which would also allow for a more certain generalization from contexts to domains.

The cross-classified CFA model indicated construct validity and the items' suitability to measure students' interest in science with respect to the four postulated parts (domain, subject matter, context, and activity). However, all statistical models are typically only approximations to describe reality. Alternative models are imaginable that could fit the data similarly well or even better. In addition, good fit indices do not guarantee the inclusion of all important variables (Goffin, 2007; MacCallum & Austin, 2000; Tomarken & Waller, 2005).

Another concern might be the limited number of participants ($N = 464$) and the obvious question whether the model is suitable to describe interest in science for other age groups as well. In this sense, our next study will extend the number of participants and investigate a development over time with a combined cross-sectional and longitudinal study. A larger number of participants allows for more detailed statistical analyses. For instance, latent class analyses might show different interest patterns in dependence of traits such as science self-concept or gender.

CONCLUSIONS

Our main goal to generate an instrument that could be used to examine interest structures of students at the very beginning of their secondary science education was successfully attained. The consideration of RIASEC + N facets to systematically categorize science activities seems to be a promising approach to characterize students' interest in science school activities (and therefore science) more precisely. Such a categorization could considerably contribute to the development of curricula, lessons, and extracurricular activities. Structuring science classes into RIASEC + N activities in connection with everyday contexts and giving students the possibility to choose from different activities according to their interests might therefore enable, as intended, to launch "initiatives that engage students in interesting and motivating science experiences." (de Jong et al., 2013, p. 305) and to "teach our science students to do something in science class, not to memorize facts." (Alberts, 2013).

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