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Measuring Interest: Development and Application of a Three-Dimensional Situational Interest Short Scale

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Abstract: Situational interest is an important factor that has a great influence on learning success in both in-school and out-of-school learning situations. Although there has been extensive research on interest in its diverse forms for decades, an evaluated measurement instrument for situational interest that covers the three theoretically defined components of interest (emotional, cognitive, value-related) is still missing. Therefore, in this study, based on person-object theory of interest, a short scale was developed that can be used in a variety of learning programs independent of content or methods. In study 1, eight suitable items were selected and their structure was examined using exploratory methods. In study 2, the results of study 1 were verified using confirmatory factor analyses. Study 3 shows an example of a practical application of the newly developed scale in two different learning settings. The findings provide evidence that the scale developed here is a practical instrument to measure situational interest taking into account all its components. On the one hand, the scale can help teachers evaluate their educational programs; on the other hand, it can be used by researchers to empirically investigate the construct of interest. Thus, the scale makes an important contribution to research and practice.

Keywords: *Components of interest, scale development, situational interest, Situational Interest Short Scale.*

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Introduction

There has been extensive research on interest in its diverse forms for decades and several instruments have been developed for its measurement. Nevertheless, until now a theoretically satisfying instrument to measure situational interest that can be used in a variety of learning programs, even with younger students, was missing. In order to fulfil these properties, the instrument had to cover the three theoretically defined components of the interest construct (emotional, cognitive, and value-related) and take into account other quality criteria such as a low number of items and their good comprehensibility.

Theoretical Background

Interest has long been considered beneficial for learning, encompassing both learning processes and learning outcomes (Dewey, 1993, as cited in Renninger & Hidi, 2015). Research shows that interest indeed affects a person's attention, goal setting, strategies and levels of learning as well as conceptual understanding (for summaries see Hidi & Renninger, 2006; Renninger & Hidi, 2015; Schiefele, 1991). Interest can lead to positive affect and persistence (Ainley et al., 2002) and makes students more likely to voluntarily engage with content again (Hidi & Renninger, 2006). It therefore becomes an important influencing factor particularly when learning is less structured and learning activities are not primarily influenced by extrinsic values such as written examinations (Köller et al., 2001). Hence, interest plays an important role not only in school but also in out-of-school and life-long learning.

The development of interest can be influenced by internal factors – a person's individual characteristics such as gender and age, or psychological variables such as prior interest or self-concept – and external factors including the quality of instruction and instructional practices (Fryer & Ainley, 2019; Harackiewicz & Knogler, 2017). Typical schooling, however, often fails to foster the students' interest development, and research findings point to the need to reform education (e.g., Christidou, 2011). There is great potential for changes in educational practice based on findings from interest research (Harackiewicz & Knogler, 2017). Such research requires several disciplines working together (e.g.,

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educational psychology, educational research, subject education, science education) to contribute to a better understanding of how interest in specific fields arises, how it increases or disappears, and how it can be fostered (Krapp & Prenzel, 2011). Interest and its development in educational settings have therefore become central topics in education research, and research groups worldwide are conducting investigations of interest (Renninger & Hidi, 2011). However, the research questions and methods used are not always aligned. Empirical work often does not describe the conceptualization of interest, and the links between conceptualizations and the choice of measurements and methods are often not elaborated. In order to be generally applicable and provide guidance for educational practice, research on interest must be theoretically sound (Renninger & Hidi, 2011).

As a theoretical framework for our studies, we use an educational theory of interest, the so-called 'person-object theory of interest' (POI) (Krapp, 2002a, 2007). POI has been developed by researchers from educational psychology who aimed at improving educational practice. According to this theory, interest represents a specific relationship between a person and an object. An object of interest can refer to a concrete thing, a topic or content, a school subject (e.g., biology), or an abstract idea (Krapp, 2002b; Krapp & Prenzel, 2011). This clear orientation towards an object distinguishes interest from many other motivational constructs, such as goal orientations, self-concept, motives or needs, which are also regarded as conditioning factors of learning motivation (Schiefele, 2009).

For an interest to develop, a situation-specific interaction between the person and the object is required (Krapp et al., 1992). This specific interaction can be realized in many forms, whenever a person interacts with its environment, such as a concrete hands-on engagement with the object (e.g., touching a plant), cognitive work on a specific problem (e.g., analyzing scientific data) and the unconscious engagement with certain ideas (e.g., day-dreaming) (Krapp, 2002a). Interest can develop from such an interaction triggered by contextual factors and external circumstances in this situation ("interestingness", Hidi & Baird, 1986). This so-called situational interest is characterized by increased attention and cognitive functioning as well as feelings of curiosity and fascination (Schiefele, 2009). It may be temporary and disappear after the completion of the interaction. If situational interest is maintained – e.g., through external support (by peers, teachers, by tasks or by specific features of the learning environment) – the relationship between the person and the object can stabilize. The person may then continue to seek further engagement with the object. Over time, and based on numerous person-object-interactions that are experienced as altogether positive, a deeper form of interest can develop that is no longer dependent on external factors and conditions in the situation of the interaction. Such a stable relationship between person and object is referred to as individual interest (Harackiewicz & Knogler, 2017; Krapp, 1998, 2002a; Schiefele, 2009).

Based on the person-object theory of interest, Upmeier zu Belzen and Vogt (2001) developed an extended concept, which defines not only situational and individual interest, but also "indifference" and "non-interest". Indifference is considered as a neutral position, as the person has not yet been in contact with the object. In contrast to this, non-interest develops due to a person-object-interaction that is altogether not experienced as positive ("disinterest") or even as negative ("aversion"). In the latter case, future engagements with the object will be actively avoided. In educational contexts, the aim should be to prevent non-interest and instead find ways to promote learning based on (situational) interest.

The interest relation between person and object is characterized by cognitive and affective components (Hidi & Renninger, 2006): a person who is interested in an object wants to learn more about it and acquire new information. The person accumulates knowledge over time due to intensive involvement with the object. The engagement with the object of interest is usually accompanied by positive feelings, such as enjoyment, well-being or the satisfaction of fundamental psychological needs ("basic needs", Deci & Ryan, 1993; Krapp, 2002a). However, negative feelings, like fear or disgust, can also be involved, especially in early phases of the interest development, when the person's attention is caught (Renninger & Hidi, 2015). A third characteristic of interest refers to the individual's values: the object of interest is considered to be of personal significance and meaningful (e.g., important in real life; Mitchell, 1993) and – especially in later phases of the interest development – the goals and intentions related to the object are compatible with the attitudes and values of the person's self/identity (Krapp, 2002a).

In the initial phases of interest development ("triggered situational interest", Hidi & Renninger, 2006; "catch", Mitchell, 1993), emotional aspects – positive or negative feelings – dominate. Nevertheless, Renninger and Hidi (2011) assume that both cognitive and value-related aspects also play an important role, especially as interest grows. All three characteristic components–emotional, cognitive, value-related – must therefore be taken into account in the measurement of interest.

Fostering interest as a prerequisite, means and goal of education is thus an important challenge in educational contexts (Krapp & Prenzel, 2011). Situational interest should be the focus of consideration, as teachers – and educators in informal learning environments – have no influence on the learners' individual characteristics and psychological variables such as existing individual interests (Mitchell, 1993). Situational interest, however, can be influenced by specific tasks or the design of the learning environment and thereby override individual differences (Hidi & Anderson, 1992; Renninger & Hidi, 2011). Over a longer period of time, educational activities can also influence the development of individual interest (Palmer et al., 2017). Educators should know ways to support their students' interest development in order to enhance educational opportunities for all learners (Renninger & Hidi, 2020).

Measuring Situational Interest

In recent years, a number of different measurement instruments have been developed to assess situational interest. However, some of these measurement instruments consist of only a single item (Lin et al., 2013; Loukomies et al., 2015; Palmer, 2009; Tapola et al., 2013) or less than 5 items (Gungor et al., 2007; Moreno, 2009; Zhu et al., 2009). This type of measurement, while simple and time-saving in practical implementation, is less well suited to address and adequately capture the different components of the interest construct (Potvin et al., 2023; Renninger & Hidi, 2015).

On the other hand, measurement instruments with 20 or more items (Chen et al., 1999; Mitchell, 1993; Potvin et al., 2023) pose particular challenges to students with special educational needs, beginning readers, or children with shorter concentration skills and are therefore often not applicable there (Kleespies, Braun et al., 2021; Kleespies, Doderer et al., 2021). Regarding the target group, measurement instruments that work for polytechnic students (Rotgans & Schmidt, 2011a, 2011b), undergraduates (Durik & Harackiewicz, 2007; Hulleman et al., 2010), or university students (Harackiewicz et al., 2008) are not automatically appropriate for students with learning disabilities (Kleespies, Braun et al., 2021). In an educational context, shorter scales are generally more suitable as, on the one hand, less teaching time is lost in completing the questionnaire. On the other hand, shorter scales are also more likely to be suitable in inclusive settings, for example if students with shorter attention spans or special needs are to be surveyed.

Another problem in finding an appropriate instrument to measure situational interest is the limited applicability due to their subject specificity. For example, many scales explicitly refer to mathematics education (Durik & Harackiewicz, 2007; Linnenbrink-Garcia et al., 2010; Mitchell, 1993). In addition, there are measurement instruments focusing on sports (Chen et al., 1999), chemistry (Nieswandt, 2007), literature (Schraw, 1997) psychology (Harackiewicz et al., 2008; Hulleman et al., 2010), or museum visits (Lewalter & Geyer, 2009).

A weakness of many measurement instruments is the lack of coverage of the different components of the interest construct as described in the POI (see above). For example, Tsai et al. (2008) and Linnenbrink-Garcia et al. (2010) lack items that address the cognitive component. The scales of Rotgans and Schmidt (2011a, 2011b) do not include items on the value-related component. However, even if seemingly all components are covered by the wording of the items, their assignment can often only be partially confirmed statistically by exploratory factor analyses (Lewalter & Geyer, 2009; Potvin et al., 2023).

As situational interest is a multidimensional construct that includes an emotional, cognitive and value-related component (Ainley, 2017; Hidi & Renninger, 2006; Prenzel et al., 1986), each of these components contributes to the overall interest in a unique way. In order to assess which of these components is addressed by an educational program or a teaching topic, a differentiated measurement of the individual components is necessary. This would make it possible to identify which components of interest are promoted by an educational program, but also where there may still be a need for improvement. In addition, a multidimensional scale has the advantage that researchers could use it to investigate which measurements in educational programs particularly address individual interest components, allowing them to develop recommendations for teachers and educators.

The aim of this study was to develop a measurement instrument for situational interest, which can be used in different age groups, from young middle school students to high school students. To ensure that the instrument can be used especially with young students and students with special needs, it should contain only a few, simply formulated items, but at the same time map the components of the situational interest in a way that is not only theoretically but also statistically verifiable. Due to the short and simply formulated items of the scale, it should be possible to use the instrument also for students with learning disabilities. The items should relate to the immediately preceding lesson, regardless of its content or methodology. In study 1, suitable items for measuring situational interest were first selected on the basis of the construct of interest (POI) and subjected to an exploratory factor analysis (EFA) after application to a larger sample. On another sample, the factor structure thus determined was checked and supported using a confirmatory factor analysis (CFA) (study 2). In study 3, the newly developed measurement instrument was used to examine two different interventions with regard to their effects on the three components of situational interest. An overview of the study design can be found in Figure 1.

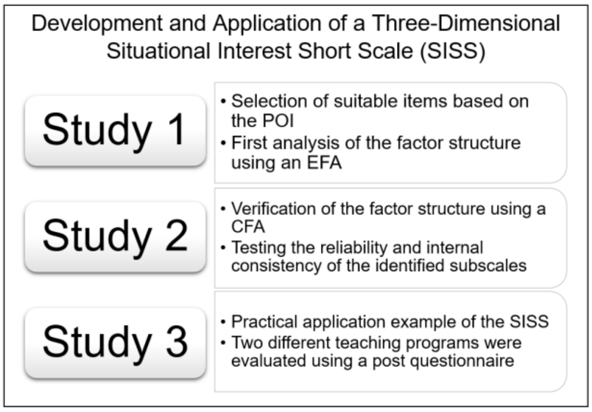

Figure 1. Study Design. Three Sub-Studies Were Conducted to Develop the SISS.

Study 1

In study 1, to ensure the highest possible content validity, an inductive approach was used (Hinkin, 1998) and eight items were selected to represent the targeted three-dimensional Situational Interest Short Scale (SISS) based on the underlying psychological construct (Rusticus, 2014), the POI. The items were then analyzed using an EFA, which is a structure exploration procedure. EFA is used to structure large amounts of data of which the structure is not exactly known. In this process the individual questions or items are assigned to higher-order factors in order to simplify the interpretation (Yong & Pearce, 2013).

Methodology

Measurement

The selection and adaptation of the items from the abundance of established scales was based on the following criteria: (a) The three components of situational interest (emotional, cognitive, value-related) should be covered as well as possible. (b) No more than 10 items should be included to ensure that the instrument can be used for the evaluation of educational programs or learning units without spending too much time. (c) The items should be simply worded so that students with support needs can answer them, and (d) the items should relate to the immediately preceding learning unit, regardless of its content or methodological design. This is intended to make the scale universally applicable across different educational subject areas and age groups. Table 1 shows the items that were selected to represent the three-dimensional SISS aiming to measure situational interest distributed across the three dimensions (Emotional [EMO], Cognitive [COG], and Value-related [VAL]). In the case of guided tours, the word "lesson" has been replaced by "guided tour".

Table 1. The Selected Items of the Developed Three-Dimensional SISS Divided According to the Three Components (Emotional, Cognitive, Value-Related) of the Theory of Interests.

Components of interest	Abbreviation	Item	Source
Emotional	EMO_1	The lesson inspired me.	Mitchell (1993)
	EMO_2	The lesson was exciting.	Chen et al. (1999)
	EMO_3	I was very concentrated during the lesson.	Rotgans and Schmidt (2011a)
Cognitive	COG_1	I would have liked to work on the topic in the next lesson.	Nieswandt (2007)
	COG_2	I would like to know more about this topic.	Rotgans and Schmidt (2011a)
	COG_3	This lesson made me curious.	Lewalter and Geyer (2009)
Value-related	VAL_1	What I learned today can help me someday.	Linnenbrink-Garcia et al. (2010)
	VAL_2	What I learned today is useful for me.	Linnenbrink-Garcia et al. (2010)

In the case of guided tours, the word "lesson" has been replaced by "guided tour".

Participants

A total of 480 respondents (49.2% female, 48.3% male, 2.5% no answer) were surveyed. The sample size was above the value of 300 recommended by Comrey and Lee (1992) for conducting an EFA. The participants were middle school students in grades five, six to seven, and their ages were ranged from 9 to 15 years (M = 11.61; SD = 2.31). The students were part of inclusive learning groups. This means that students with cognitive learning disabilities were also taught in these courses. The students were surveyed after participating in a guided tour at either the Frankfurt Zoological Garden or the Senckenberg Natural History museum in Frankfurt am Main (Hesse, Germany). Participation was voluntary and written consent was obtained from the parents and the school administration. There were no negative consequences if individual students did not participate. Both the local ethics committee and the responsible school authority in Hesse (Germany) approved the study.

Data Analysis

In order to investigate the factor structure of the eight selected items, an EFA was applied. EFA is a statistical method that can help to examine the factor structure, sampling adequacy and internal consistency of an instrument (Yasir, 2016). The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were executed to determine that the data was appropriate for an EFA and supported construct validity (Yu & Richardson, 2015).

The number of factors was set at three based on the theoretical consideration of the construct of interest. A two-factor solution can be found in Appendix Table 1. Promax (Kappa = 4) was selected as the oblique rotation method because the three factors of interest are parts of the same construct and, therefore, may correlate with each other. To investigate the reliability of the individual subscales, the Cronbach's alpha score was calculated (Field, 2013). All statistical analysis was executed using IBM SPSS 28.

Results

The Bartlett test was significant ($p < .001$) and the Kaiser-Meyer-Olkin test (KMO = 0.913) was in the optimal range according to the common interpretation (Kaiser & Rice, 1974), supporting sampling adequacy and the applicability of factor analysis. Factor 1 explains 59.36%, factor 2 9.26% and factor 3 7.90% of the variance. The results of the factor analysis are shown in Table 2.

Table 2. Results of the Exploratory Factor Analysis (EFA) Using Promax Rotation of the Situational Interest Short Scale (SISS) (N=480).

	Factor		
	1	**2**	**3**
EMO_2	.873		
EMO_1	.774		
EMO_3	.675		
COG_2		.896	
COG_1	.212	.567	
COG_3	.206	.407	.235
VAL_2			.907
VAL_1		.181	.573
Alpha score	.838	.803	.770

The number of factors was fixed to 3. Factor 1 represents the emotional, factor 2 the cognitive, and factor 3 the value-related component of situational interest. Factor loadings <.30 are not displayed. Cronbach's alpha values were calculated separately for each factor.

Discussion

The results of the EFA correspond with the theoretical assumptions under which the scale was developed. Thus, a clear separation of the eight items into the three theoretical factors of the interest construct is evident. This distinguishes the scale developed here from a whole range of interest scales that treat situational interest unidimensional (Gungor et al., 2007; Hulleman et al., 2010; Rotgans & Schmidt, 2011a). Factor 1 represents the emotional component of situational interest, which is about (positive) feelings triggered by contact with the object of interest (in this case, the lesson and its topic) (Ainley, 2017; Hidi, 2006; Prenzel et al., 1986). In comparable studies, this component with similar items has been called, for example, emotional engagement (Nieswandt, 2007) or total interest (Chen et al., 1999).

The second factor represents the cognitive component, which is dealing with whether a person wants to engage further with the topic and gain more knowledge (Hidi & Renninger, 2006; Pawek, 2009). In other survey tools, this component is also called epistemic (Krapp & Prenzel, 2011) or enjoyment (in dealing with the topic in the next lessons) (Nieswandt, 2007). The third factor represents the value-related component of interest, which expresses personal importance and appreciation (Krapp & Prenzel, 2011; Prenzel et al., 1986). The three factors are based on the person-object theory of interest described in the theoretical background. The advantage of this scale over unidimensional measurement instruments is that it is possible to check which component of the interest construct was better addressed after for example a learning unit. An example of this can be found in study 3.

It should be mentioned that there are some cross-loadings of the items to the different higher-order factors. However, this does not affect the assignment of the individual items to the higher-order factors, since the highest "main" factor loading for each item is particularly distinct from these cross-loadings. The cross-loadings indicate that the individual components are not completely independent, but that there is some connection between the factors.

The one exception with two cross loadings is COG_3 ("This lesson made me curious."). In addition to the high factor loading on the theoretically assigned cognitive component, it also shows comparably high factor loadings on the other two components. A possible explanation could be that this item cannot be separated from the other two components as sharply as the remaining items. From this perspective, the fact that the lesson made someone curious also potentially includes an emotional or value-related component of interest in addition to the cognitive one. For example, it is easy to understand that the lessons aroused curiosity not only about new content (cognitive component) but also about new, positive emotions (emotional component). Some authors even refer to curiosity as an epistemic emotion, which demonstrates the close connection between the cognitive and emotional component (Hoferichter et al., 2021; Vogl et al., 2018). It is therefore comprehensible that cross-loadings also occur in this case.

It should be noted that the individual components capture the same higher-level construct, which is also understood by some authors as a unidimensional. Therefore, and since the cross-loadings are plausible, they should not be interpreted as a weakness of the measurement instrument, but as evidence of the close connection between the three components of interest. For the further analysis, the item COG_3 was included in the cognitive component of interest, because it best fits to this component and at the same time shows the highest factor loading there.

The alpha scores for the individual subscales provide indications of their reliability. The alpha values should be at least above a value of .70 to confirm the internal consistency of a scale (Tavakol & Dennick, 2011). In our case, the alpha values for all three subscales are significantly above this threshold. For the third subscale, however, it should be noted that due to the small number of items, the reliability of the scale may be underestimated when calculating the alpha value (Eisinga et al., 2013). Since the alpha score for this component is also above the value of .70, the internal consistency of the component can be expected despite the potential underestimation of the value. Having established the initial groundwork with the development and validation of the SISS in study 1, we will now focus on a confirmatory approach in study 2, which examines the factor structure and dimensionality of the scale in more detail.

Study 2

After gaining initial evidence for the factor structure of the interest scale using exploratory methods, in the next step a CFA was used to further examine and analyze the measurement tool. The advantage of CFA compared to EFA is that the factor structure is not explored, but rather predetermined by the researchers and examined using data (Worthington & Whittaker, 2006). Thus, the CFA is a common tool to explore the factor structure and dimensionality of a scale (Brown, 2015). In this context, it is important to use a new dataset for the CFA and not re-use the data from the EFA, because otherwise the results will be biased (Carpenter, 2018; Tay & Jebb, 2017; Worthington & Whittaker, 2006).

Methodology

Three models were tested with CFA. Model 1 is a single factor solution in which all items are assigned to one higher-order factor. This is consistent with the theoretical considerations of a number of authors (Gungor et al., 2007; Hulleman et al., 2010; Lin et al., 2013; Loukomies et al., 2015; Palmer, 2009; Rotgans & Schmidt, 2011a; Tapola et al., 2013). Model 2 follows the factor structure in Appendix Table 1, with items assigned to two higher-order factors. Model 3 is based on the theoretical considerations and factor analysis from study 1. It was not possible to test a model with more than 3 factors, since otherwise factors with only one item would emerge.

Participants

A total of 411 respondents were surveyed for this sub-study (47.2% female, 47.0% male, 5.8% no answer). As in study 1, these students were questioned in the context of various learning units and educational programs. Among the classes surveyed were regular classes of various school types, special education classes, elementary school classes as well as middle school classes in order to cover a wide spectrum of different students. At the time of the survey, students were between 7 and 15 years, with an average age of 10.83 years (SD = 1.55). The survey was reviewed and approved by the responsible Ministry of Education in Hesse (Germany), as well as by the local ethics committee and the principal of each school. Parents were informed about the aim of the study and asked to provide written informed consent.

Analysis

Confirmatory factor analyses were conducted using IBM's Amos 28. Maximum likelihood (ML) was selected as the fitting function, as it is the most widely used fitting algorithm (Brown & Moore, 2012). Common fit indices were selected to assess the goodness of fit of the selected models (Boateng et al., 2018; Tay & Jebb, 2017): the Chi-square test ($\chi 2$), Chi square/degrees of freedom ($\chi 2$/df), Root Mean Squared Error of Approximation (RMSEA), Tucker Lewis Index (TLI), Comparative Fit Index (CFI) and Standardized Root Mean Square Residual (SRMR). In order to test the reliability and initial consistency of the subscales of the SISS, in addition to Cronbach's alpha, the composite reliability (CR) according to Fornell and Larcker (1981) was calculated:

$$CR = \frac{(\sum_{i=1}^{p} \lambda_i)^2}{(\sum_{i=1}^{p} \lambda_i)^2 + \sum_{i=1}^{p} Var(\varepsilon_i)}$$

Results

A highly significant χ2-test was found for all three models. The remaining fit indices differ significantly between the three models. The fit indices for the individual models are shown in Table 3. The factor loadings of the individual items to the higher-order factors in model 3 are in a high range (between .54 and .83). The correlations between the higher factors are between .73 and .86. The factor loadings for all items are shown in Figure 2. The classification of the items into factors is based on the structure of the construct of interest and the results of study 1. The values on the arrows from the higher-ordered factors to the individual items are factor loadings. The values on the double arrows between the latent variables are correlations.

For the emotional component, a Cronbach's alpha value of .771 and a CR value of .780 were obtained. A Cronbach's value of .823 and a CR value of .826 were calculated for the cognitive component and for the value-related component, a Cronbach's value of .798 and a CR value of .799 were determined.

Table 3. Results of the CFA (N = 411) for the Three Tested Models.

	χ2	p	df	χ2 /df	CFI	TLI	RMSEA	SRMR
Model 1	180.92	p < .001	20	9.046	.899	.858	.140	.0545
Model 2	143.62	p < .001	19	7.559	.922	.885	.126	.0485
Model 3	58.76	p < .001	17	**3.457**	**.974**	**.957**	**.077**	**.0294**

Model 1 represents a one-dimensional factor solution, model 2 a two-factor solution, and model 3 with three factors is consistent with the theoretical assumptions about the construct of interest and the results of study 1. Excellent values for χ2/df, CFI, TLI, RMSEA, and SRMR are shown in bold. Chi-square test (χ2), Chi square/degrees of freedom (χ2/df), Root Mean Squared Error of Approximation (RMSEA), Tucker Lewis Index (TLI), Comparative Fit Index (CFI) and Standardized Root Mean Square Residual (SRMR).

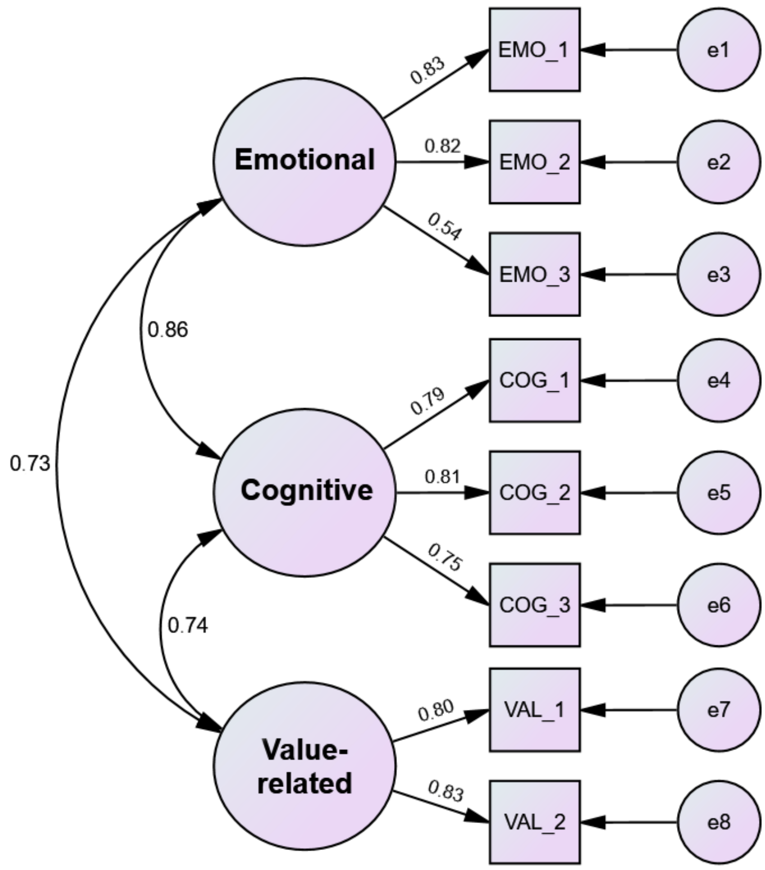

Figure 2. Factor Structure of Model 3

Discussion

CFA is a procedure that can be used to evaluate construct validity and reliability (Brown, 2015). In order to verify how well the collected data fits the theoretically model, different test and fit indices are used (Suhr, 2006). For these indices there are no exact cut of values, but only different rules of thumb. The Chi square test should not be significant for an optimal model fit. However, the p-value is strongly dependent on the sample size and becomes significant especially with large samples, as in this study, even with a good model fit (Alavi et al., 2020; Marsh et al., 1988). Therefore, other fit indices are often used.

A value often considered is the ratio of the chi-square statistic to the respective degrees of freedom ($\chi2/df$). While some authors suggest values of less than 3 (Carmines & McIver, 1981), other authors also tolerate values of up to 5 (Wheaton et al., 1977). Other frequently used fit indices are Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) (Boateng et al., 2018). Depending on the authors, for CFI and TLI, values higher than 0.90 (Awang, 2015; Browne & Cudeck, 1992) or 0.95 (Hu & Bentler, 1999) are acceptable. For RMSEA, values below 0.08 or 0.10 are in the optimal range (Awang, 2015; Browne & Cudeck, 1992; MacCallum et al., 1996) and for SRMR, values below 0.06 are desirable (Hu & Bentler, 1999).

Of the three models tested, model 3 shows the best model fit, while only an insufficient model fit could be determined for models 1 and 2. In other words, the selected models 1 and 2 do not fit the empirical data. Especially the RMSEA is outside the optimal range. Model 3, on the other hand, shows an almost optimal model fit. Even if the stricter cut-off values are applied to this model, all tested indices are in the optimal range except for the $\chi2$ /df. With a value of just over three, however, the $\chi2$ /df can also be regarded as confirmation of the model fit (Wheaton et al., 1977). The Cronbach's alpha values for all three components of this model are in the acceptable range (>.70; Tavakol & Dennick, 2011). The CR values are also in the acceptable range with values above .60 for all three components, providing important evidence for the reliability and internal consistency of the components of the third model (Ahmad et al., 2016).

The results support that model 3 fits the collected data best (Suhr, 2006). Therefore, it can be assumed that the measurement instrument developed here can indeed reflect the three components of interest described in the interest theory (POI). The factor loadings of the individual items to the higher-order factors are also high, which is further evidence of the good model fit. In this way, the measurement instrument developed here differs from other research approaches in which the interest construct was recorded one-dimensionally (Gungor et al., 2007; Hulleman et al., 2010; Rotgans & Schmidt, 2011a). The advantage of a multidimensional scale is that the different components of interest can be measured independently of each other. In this way, it is possible to investigate the extent to which the three components of situational interest are addressed by different learning units. With the multidimensional structure of SISS confirmed in study 2, our focus in study 3 shifts to practical applications by demonstrating the usefulness of the scale in measuring situational interest across different learning units and age groups, gaining valuable insights into the different components of interest and the applicability of SISS.

Study 3

To demonstrate the advantage of the multidimensional scale developed here, in study 3, situational interest was measured and analyzed after two different learning units. One learning unit was a project day (approximately 4 hours) with a focus on spiders, the other was a single lesson (approximately 1 hour) with live amphibians. The study will focus on the individual components of interest within the learning units.

Methodology

The learning units were conducted at different schools in Hesse (Germany). All surveys were voluntary, and non-participation did not result in any disadvantages. The parents were informed about the study and asked for their written consent. The surveys were conducted immediately after the interventions.

Learning Unit 1: Amphibians

The learning unit was conducted in different types of schools. A total of 178 students (47.8% female, 50.0% male, 2.2% no answer) were included. Of these, 56 students attended a primary school class, 67 attended a middle school, and 55 students were in a special education class. The age ranged from 9 to 15 and the average age was 11.37 (SD = 2.35) years.

The learning unit was a 60-minute school lesson focusing on amphibians. For this purpose, a member of the university staff visited each school class with a number of amphibians in terrariums. Among the animals brought were common toads (*Bufo bufo*), tadpoles of common frogs (*Rana temporaria*), and fire salamanders (*Salamandra salamandra*). Since some of the animals brought have a protected status in Germany, a permit from the nature conservation authority was obtained (species protection exemption according to § 45 of the Federal Nature Conservation Act).

The students observed and described the characteristics of amphibians (such as the moist skin) on the living organisms. The students were allowed to touch the toads very carefully. The lesson also included feeding the toads with mealworms to observe the feeding behavior of the animals. At the end of the lesson, the school classes were given tadpoles so that they could observe the metamorphosis of the toads over the next few weeks.

Learning Unit 2: Spiders

The learning unit focusing on spiders was conducted in a school with seven classes. A total of 149 (46.4% female, 47.1% male, 6.5% no answer) students participated, with an age range of 10 to 13 years and an average age of 11.31 years (SD = 0.70).

The learning unit was a station work over two double lessons (180 minutes). The stations were prepared and conducted by a member of the university staff. At one of the stations, students were able to observe live wasp spiders (*Argiope bruennichi*) and also hold them in their hands. At the other stations, the body structure was examined on preserved spiders, or topics such as habitat, web building, reproduction or the correct handling of spiders were dealt with using traditional working materials.

Analysis

Since the data were not normally distributed (Kolmogorov-Smirnov test: $p < .001$) and the three components of situational interest were to be compared within the respective learning unit, to find out which pairs were different, the non-parametric Friedman test was applied. For significant results, a post hoc test (Dunn-Bonferroni test) was performed and the effect size was calculated using the formula $r = \frac{z}{\sqrt{N}}$ (Fritz et al., 2012). IBM SPSS 28 was used for the analysis.

Results

Table 4. Means and Standard Deviation for Each Component of Individual Interest and Overall Interest for the Two Learning Units.

	Learning unit 1: Amphibians	**Learning unit 2: Spiders**
Emotional	4.16 ± (0.75)	3.90 ± (0.80)
Cognitive	3.90 ± (1.07)	3.45 ± (1.01)
Value related	3.63 ± (0.99)	3.45 ± (1.07)
Overall interest	3.93 ± (0.81)	3.62 ± (0.82)

High overall interest was found for both learning units. The Friedman test was significant for both projects ($p < .001$), indicating a difference between the components of interest within the programs.

When comparing the different components of situational interest pairwise in the amphibian lesson, a significant difference was found between the emotional and value-related components of interest ($p < .001$; $r = .301$). A significant difference was also found between the cognitive and value-related component ($p < .001$; $r = .211$). There was no significant difference between the emotional and the cognitive one ($p = .318$). The results for the amphibian project are shown in Figure 3. The fourth box represents the overall situational interest. Significant shifts are marked with * $p < .05$, ** $p < .01$, *** $p < .001$ (n.s. = not significant).

For the project day focusing on spiders, a significant difference was found between the emotional and the value-related component of interest ($p < .001$; $r = .238$) and between the emotional and the cognitive component ($p < .001$; $r = .319$). No significant difference was found between the cognitive and value-related one ($p = .498$). The results for the education program focusing on spiders are shown in Figure 4. The fourth box represents the overall situational interest. Significant shifts are marked with * $p < .05$, ** $p < .01$, *** $p < .001$ (n.s. = not significant). Mean values and standard deviation for both learning units are shown in Table 4.

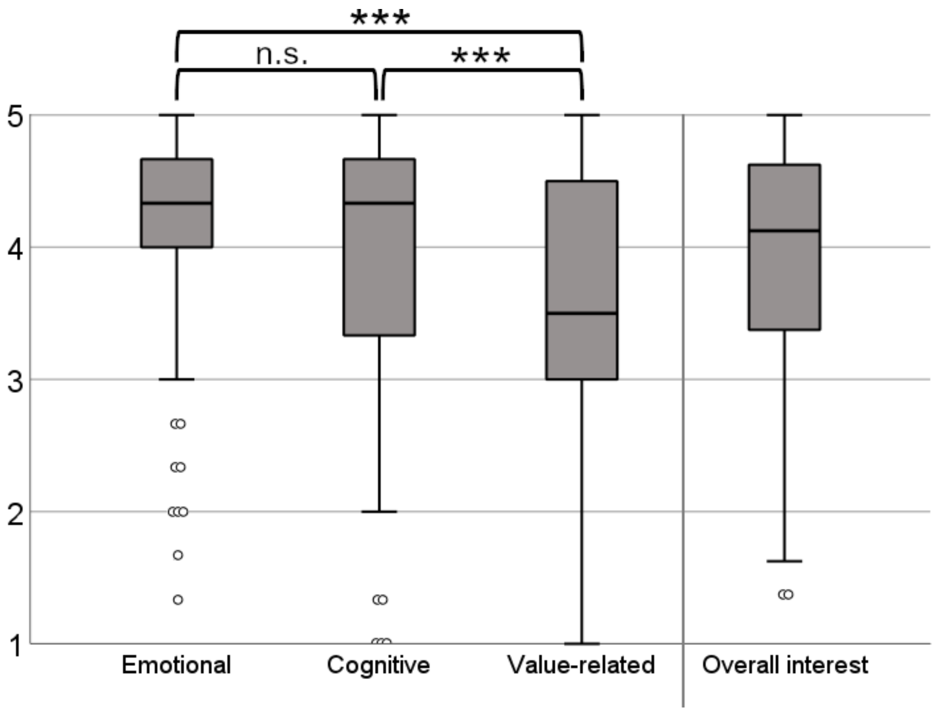

Figure 3. Comparison of the 3 Components of Situational Interest for the Learning Unit Focusing on Amphibians.

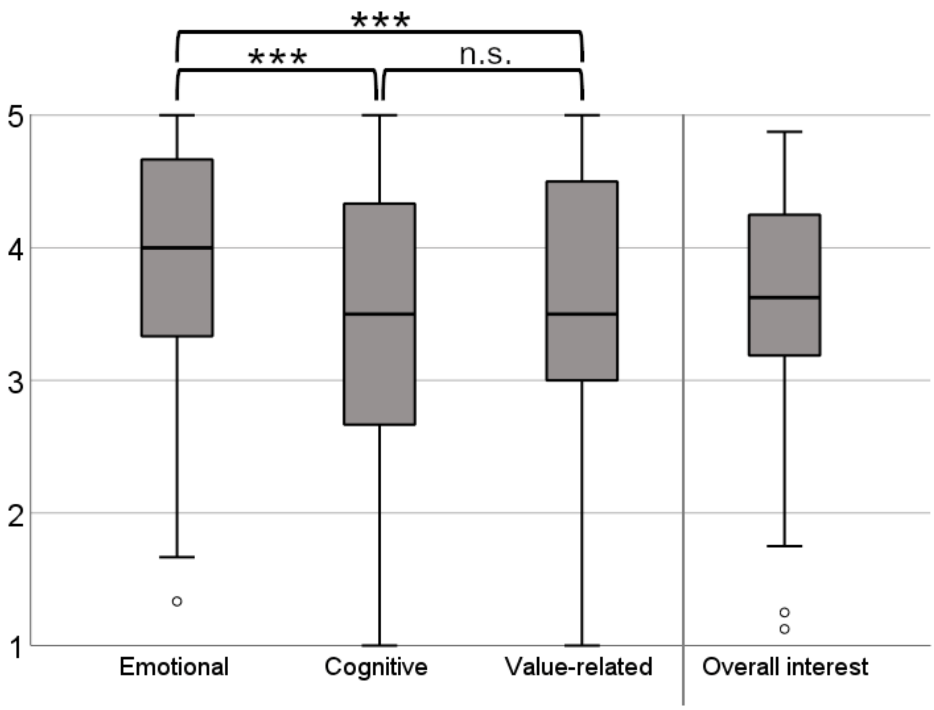

Figure 4. Comparison of the 3 Components of Situational Interest for the Learning Unit Focusing on Spiders.

Discussion

The findings show the advantage of the scale which consists of multiple factors compared to a one-dimensional scale. Thus, the instrument makes it possible to determine which components of interest have been addressed in the different learning units. This allows to determine where there may still be a need for improvement.

For the learning unit with spiders, the emotional component of interest was rated higher than the cognitive and value-related components. Previous studies have shown that the emotional component of interest is particularly triggered when a strong reaction, such as enthusiasm, is generated (Schraw et al., 2001). That animals can particularly trigger emotions has been demonstrated in previous research (Clayton et al., 2009; Myers et al., 2004). Entertaining elements can also help to promote the emotional component of interest (Harp & Mayer, 1997). Therefore, it is possible that the animal contact with the spiders and the special character of the project day, which differed from regular classes, contributed to the fact that the emotional component in particular was developed. Thus, the students might have experienced a positive emotional perception of the lesson and the topic. Further studies with additional qualitative data are needed to substantiate such assumptions.

Compared to the project day with spiders, slightly higher values were reached in the lesson with the focus on amphibians. The emotional interest component was rated particularly high. A possible explanation for this could be that the lesson with amphibians focused particularly on the experience with the animals. The children were allowed to interact with the live animals and even hold them in their hands. Working with worksheets or books was completely avoided. This special learning situation may have particularly contributed to the increase in the emotional component of interest. The teacher could also have had a great influence on the students' interest in this form of teaching. There is evidence that a teacher who shows enjoyment can transfer positive emotions to the learners (Frenzel et al., 2009). Therefore, it is plausible that a motivated teacher who introduced and presented the amphibians contributed to the positive development of the emotional component of interest. In contrast, during station work, as was done during the project day with spiders, the teacher stepped more into the background and therefore had fewer opportunities to transport this motivation.

In addition, in the amphibian lesson, the cognitive component was rated significantly higher than the value-related component, besides the emotional component. It is possible that the direct and intensive animal contact created a desire to continue studying amphibians in the future. The comparatively short learning unit and the special form of teaching could also have created the wish to continue studying the topic in the next lesson. According to Rotgans and Schmidt (2014), the perception of a lack of knowledge in particular promotes the emergence of situational interest. Additionally, the tadpoles left in the classroom could be seen as an added incentive to want to engage with amphibians in the coming time as well.

On the other hand, the longer learning unit focusing on spiders might have satisfied the students' need for knowledge for the time being, so that they were less motivated to learn more about the topic in the near future.

The value-related component was rated significantly lower than at least one other component in both learning units. This suggests that after both programs, students rated the importance of what they learned as less important for their life. In order to increase this component, the everyday relevance of what has been learned for the students should probably be emphasized and worked out more precisely. In the future, further studies are necessary to clarify which factors have an influence on the different components of interest. Here it is important to supplement the quantitative surveys with interview and observation data (mixed methods), especially for younger children (Mayring, 2014; Renninger & Hidi, 2015; Tashakkori et al., 2021).

Conclusion

Interest is an important factor that has a great influence on learning success. Although the construct of interest has been researched for decades, until now there has been no theoretically satisfactory tested measurement instrument to assess situational interest, independent of the topic of an education program, that is suitable for younger students or inclusive classes. In this study, a suitable short scale was developed and tested for its factor structure. The analysis showed that the items used represent the three components of the construct of interest.

Unlike many existing instruments, the SISS offers a multidimensional lens through which situational interest can be examined. This allows the scale to be used to evaluate educational programs and to examine which component (emotional, cognitive, or value-related) of interest is particularly addressed or which interest component of a program still needs to be strengthened. This allows various types of educational opportunities to be specifically optimized to promote the different components of interest. The scale can also be used in future studies to check exactly which measures and methods have a positive effect on the different components of interest.

The potential applications of the SISS extend beyond the study samples, encompassing a broad spectrum of educational contexts and age groups. The scale's adaptability allows for its integration into various learning environments, making it a valuable tool for researchers and educators. Due to its short length, the scale can be used in heterogeneous learning and teaching groups. It is also imaginable that the carefully validated multidimensional SISS could be used for other groups, such as adults, even if the scale was not validated for them in this study. Therefore, this scale might lay an important foundation for further research.

Recommendations

The newly developed SISS can be used particularly in research. In experimental educational setups in which only individual factors are changed, using the SISS it could be investigated how these changes affect the different components of interest: For example, it would be possible to conduct the same educational program under laboratory conditions with different classes. Individual aspects of the program could be changed and the SISS could be used to investigate how the changes affect three different components of interest. This would allow conclusions to be drawn as to which factors are effective in increasing either the emotional, cognitive, or value-related situational interest. Additionally, the scale could also be used in this context to investigate whether age differences in the development of interest exist. For example, it is not clear whether measures that increase the emotional interest of fifth graders are also effective for older students. With the help of the SISS, it might be possible to investigate what differences there are between the age groups.

Teachers and practitioners can use the scale to check whether the courses they teach have a positive influence on the different components of interest. The scale can easily be implemented using a questionnaire after a teaching unit. This allows to examine which component of interest was particularly addressed. If a lesson on a topic has particularly addressed the emotional component, but less strongly the value-related component, the teacher can emphasize the value of what has been learned for the students in the next lesson. In addition, the learning concept can be optimized for the next learning group so that, to stay with the example above, the value-related component is directly addressed in the improved lesson.

Limitations

Although this study was conducted with great care, some limitations must be mentioned that may affect the results. For example, the items were tested and piloted only in German. For this reason, the scale's cross-cultural validity, applicability, and reliability remain unexplored. Further research is needed to determine the psychometric properties of the instrument for other languages. Furthermore, only a low number of items was used to make the scale particularly suitable for special education and elementary school classes. This means that the individual factors are represented by only a few items, which might have a negative impact on reliability.

Ethics Statements

The studies were reviewed and approved by the Ethics Committee of the Science Didactic Institutes and Departments (FB 13, 14, 15) of the Goethe University Frankfurt am Main under approval number 15-WeBeSaDic-2204. The participants' legal guardians provided their written informed consent to participate in this study.

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authorship Contribution Statement

Kleespies: Conceptualization, Methodology, Formal analysis, Writing - Original Draft, Visualization. Scheersoi: Conceptualization, Writing - Original Draft, Writing - Review & Editing. Dierkes: Conceptualization, Writing – Review & Editing. Wenzel: Conceptualization, Methodology, Investigation, Writing - Original Draft, Writing - Review & Editing, Supervision.

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Appendix

Table A1. Results of the Exploratory Factor Analysis (EFA) Using Promax Rotation of the Situational Interest Short Scale (SISS) (N=480). The Number of Factors was Fixed to 2.

	Factor	
	1	**2**
VAL_1	.786	
VAL_2	.718	
COG_2	.641	
COG_3	.612	.206
COG_1	.480	.256
EMO_2		.869
EMO_1		.756
EMO_3		.638