Subject-specific interests and subject-specific self-concepts

Factor structures and shared as well non-shared predictive powers for academic achievements in two major school subjects

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Abstract: Academic interest and academic self-concept are important correlated motivational variables. Their common factorial structure and their shared (confounded) and non-shared (unique) power for predicting subject-tied academic achievement has not yet been satisfactorily investigated. This study investigated 588 Chinese adolescents. Two subject-tied interests and the corresponding subject-tied self-concepts were measured. The associated school marks were collected. The major subject German (first foreign language) was chosen to represent the verbal oriented school subjects, the major subject Maths was chosen to represent the numerical oriented ones. Confirmatory factor analyses (CFAs) evidenced two motivational factors (academic interest and academic self-concept) within each school subject and two subject factors (German and Maths) within each motivational construct. Joined CFAs (which included all interest as well as all self-concept items) revealed four factors (interest German, interest Maths, self-concept German, self-concept Maths). Accordingly, four motivational scales were formed. Each scale consisted of five items. The scales had high reliabilities and displayed good convergent-divergent validities. Both motivational scales together accounted for 41.0\% (German) and 22.3\% (Maths) of the total achievement variance. Of these, the common (fused) shares were 19.8\% (German) and 12.4\% (Maths). The proportions of the total achievement variance that could be explained exclusively by only one of the two motivational variables amounted to 0.3\% (interest) and 20.9\% (self-concept) for German. Theses figures were 0.1\% (interest) and 9.8\% (self-concept) for Maths. The discussion underscores that subject-specific academic interest and subject-specific academic selfconcept, while highly correlated, should still be considered distinct constructs. A subject-tied self-concept remains an important predictor of academic achievement even after controlling for the assigned interest. The situation is different in the case of subject-tied interest. Its predictive power for academic achievement collapses after controlling for the associated self-concept.

Keywords: Interest, self-concept, school subject, academic achievement, commonality analysis

Schulfachspezifische Interessen und schulfachspezifische Selbstkonzepte: Faktorielle Strukturen und geteilte sowie nicht-geteilte Vorhersagekräfte für Leistungen in zwei schulischen Hauptfächern

Zusammenfassung: Akademische Interessen und akademisches Selbstkonzept sind relevante pädagogisch-psychologische Motivationsvariablen. Ihre gemeinsame faktorielle Struktur und ihre geteilten (konfundierten) und nicht geteilten (spezifischen) Vorhersagekräfte für schulische Leistungen in unterschiedlichen Schulfächern sind noch nicht zufriedenstellend geklärt. In dieser Studie wurde 588 chinesische Jugendliche untersucht. Erhoben wurden das Interesse an zwei Hauptfächern, die entsprechenden Selbstkonzepte sowie die zugehörigen Zensuren. Die Fächer waren Deutsch (erste Fremdsprache) und Mathematik. Konfirmatorische Faktorenanalysen (CFAs) belegten zwei Motivationsfaktoren (akademisches Interesse und akademisches Selbstkonzept) innerhalb eines jeden Schulfachs sowie zwei Fachfaktoren (Deutsch und Mathematik) innerhalb eines jeden Motivationskonstruktus. Eine gemeinsame CFA, die auf allen Interessenitems und allen Selbstkonzeptitems basierte, führte zu vier Faktoren: Interesse Deutsch, Interesse Mathematik, Selbstkonzept Deutsch und Selbstkonzept Mathematik. Entsprechend wurden vier hoch reliable Skalen (pro Skala fünf Items) gebildet, die gute konvergent-divergente Konstruktvaliditäten aufwiesen. Im Fach Deutsch klärten beide motivationalen Skalen (Interesse, Selbstkonzept) zusammen 41.0\% der totalen Leistungsvarianz auf, im Fach Mathematik 22.3\%. Die geteilten (konfundierten) Anteile betrugen 19.8\% (Deutsch) und 12.4\% (Mathematik). Die nicht geteilten (also exklusiv nur durch eine der beiden Motivationsvariablen aufklärbaren) Anteile an Leistungsvarianz, beliefen sich in Deutsch bzw. Mathematik für die Interessen auf 0.3\% bzw. 0.1\% und für die Selbstkonzepte auf 20.9\% bzw. 9.8\%. Die Diskussion betont, dass fachspezifisches akademisches Interesse und fachspezifisches akademisches Selbstkonzept unterschiedliche – wenn auch höher korrelierte – Konstrukte sind und dass das schulfachbezogene Selbstkonzept auch nach Kontrolle des zugeordneten schulfachbezogenen Interesses ein wichtiger Prädiktor für akademische Leistung bleibt. Anders liegt der Fall beim schulfachbezogenen Interesse: Seine Vorhersagekraft für schulische Leistung bricht bei Kontrolle des entsprechenden schulfachbezogenen Selbstkonzepts zusammen.

Schlüsselwörter: Interesse, Selbstkonzept, Schulfach, Schulleistung, Kommunalitätenanalyse
Interest and self-concept

Academic interest and academic self-concept (hereafter always briefly referred to as interest and self-concept) are two important motivational constructs in educational psychology (O’Keefe & Harackiewicz, 2017; Marsh, 2007). Interest has always been defined as a preference for a particular topic or content and thus operationalized in a domain-specific manner, given that the concept of a general, cross-domain interest makes little psychological sense. Until the 1980s, self-concept was often conceptualized and measured in a general way (i.e. across domains) not taking the specifics of different subjects into account. Since then, self-concept has mostly been conceptualized in domain-specific terms due to the heterogeneity of school subjects. Based on a sample of Chinese adolescents, the present study aims to replicate and extend previous research findings concerning the common factorial structure of subject-tied interests and subject-tied self-concepts. Furthermore, it is designed to shed additional light on the shared (common) and non-shared (unique) power of subject-tied individual interests and subject-tied self-concepts in predicting adolescents’ corresponding academic achievements. The target subjects were German (first foreign language, representing the verbal domain) and Maths (representing the numerical domain). Thus, interests, self-concepts, and achievements were conceptualized and collected at the same level of generality / specificity.

Interest

Interest can be defined as an affective-emotional preference for a particular topic or content. It consists of two related components, namely a cognitive and a positive affective one (Hidi & Renninger, 2006; Renninger & Hidi, 2011; Schiefele, 2009). Interest is considered as a central motivational-emotional variable in psycho-educational research (Daniels, 2008; Harackiewicz et al., 2016; Krapp, 1999, 2002a, 2018; Schiefele & Wild, 2000). It is understood as a facet of intrinsic motivation (Krapp, 1999, 2002b; Ryan & Deci, 2000, 2017; Schiefele et al., 2018). Note that research has shown that “there is no such thing as general student interest” (Frenzel et al., 2010, p.509) because interests are “always … content specific” (Kang et al., 2019, p.84). With other words: “interest is necessarily related to an object”. Accordingly, Krapp (2018, p.286) therefore emphasizes that “the special characteristic [of interest] is [its] object specificity”.

The “educational-psychological interest theory”, also called “person-object theory of interest” (e.g. Krapp, 2002a, b, 2007; Krapp & Prenzel, 2011; Schiefele, 2001, 2009), distinguishes two facets of interest. A situational interest is a one-time relation to a defined task or specific topic which is evoked by incentives of given situation and only weakly linked to (academic) performance. Individual interest is understood as a trait-like preference for a particular subject or topic and is often used to predict (academic) achievement (Krapp, 2018). Furthermore, interests are relevant for the selection of courses of study at school and university as well as for career choice (Harackiewicz et al., 2016; Köller et al., 2006; Taskinen et al., 2013).

The meta-analysis of Nye et al. (2012) stated a weak correlation of vocational interests with scholastic performance (r = .23). To the best of our knowledge, only one meta-analysis has been published so far analysing the relationship between subject-tied interest and students’ academic performance (Schiefele et al., 1992). It reported exclusively positive associations (r = .31). These correlations were heterogeneous across different school subjects, ranging from biology (r = .16) and literature (r = .17) to social science (r = .34) and science (r = .35). The method of performance assessment (tests vs. school report marks) and the students’ grades did not moderate the association (for similar findings see Fryer & Ainley, 2019; Gogol et al., 2017). Rost et al. (2008) investigated the relationship between adolescents’ interests and associated marks in five subjects and found strong domain-specific correlations, ranging from r = .43 (German, mother language) to r = .58 (Maths). Clear convergent-divergent validities emerged: Each interest score correlated more highly with the assigned grade than with the marks of the other domains. Jansen et al. (2016) reported similar findings with domain-tied marks and corresponding test scores (five subjects). Like Schiefele et al. (1992), correlations were lower for tests than for school report marks. In contrast, PISA 2006 found only a weak relationship between academic achievement and interest (Organisation for Economic Co-operation and Development, 2007). More recently, Scherrer et al. (2020) also found low interest-achievement correlations (r = .20 and r = .18).

Interest seems to have weak reciprocal relationships with academic performance in adolescents (Denner et al., 2019; Köller et al., 2001; Marsh et al., 2005). However, other researchers reported small paths of interest to achievement (Fryer & Ainley, 2019; von Maurice et al., 2014) or no direct paths (Lee & Stankov, 2013). The connection of interest with academic performance is thus not yet fully clarified.

Self-concept

The self-concept amalgamates students’ cognitive representation of his or her academic success with ensuing emotional-affective reactions (Bong & Clark, 1999; Marsh,
Interest, self-concept, and achievement

Interests and self-concepts are positively related. The correlations vary depending on the school subject. Daniels (2008) found average correlations (three measurement waves) between $r_\alpha = .44$ (English) and $r_\alpha = .14$ (biology). Other studies reported even higher correlations (Denner et al., 2019; Gogol et al., 2017; Habók et al., 2020; Kang et al., 2019; Köller et al., 2006; Köller et al., 2019) up to $r = .80$ (van der Westhuizen, 2022). Whether there is a mutual interplay between interests and self-concepts or not has yet not been robustly resolved (see Fryer & Ainley, 2019; Denner et al., 2019; Kang et al., 2019; Marsh et al., 2005).

Previous studies often investigated either how much achievement variance was accounted for by subject-tied self-concepts or, to a lesser extent, by subject-tied interests. Research studying a combination of interest with self-concept in the statistical prediction of scholastic performance is surprisingly rare. Chiu and Xihua (2008) analysed PISA-2000 data and stated that “controlling for self-concept the effect of interest in Mathematics was reduced by 31%” (p. 330; see Habók et al., 2020). Lotz et al. (2018) even showed that the effect of interest on academic performance completely disappeared after controlling for self-concept (see Köller et al., 2019). Viljaranta et al. (2014) found that academic achievement in Math and reading predicted the corresponding subsequent self-concepts. However, neither interests nor self-concepts predicted subsequent academic achievement, but academic self-concepts predicted subsequent interests and the relationships between achievements and interests.

The current study

The above-mentioned findings indicate that the interplay of subject-tied interest and self-concept in the statistical prediction of subject-tied achievement needs further clarification. Typically, hierarchical regression analyses are run to quantify the incremental validities of interest and self-concept for predicting achievement. However, this method can neither quantify the amount of specific (non-shared) academic variance that can be uniquely accounted for by either interest or self-concept nor offer robust evidence for the common (shared) effect. Furthermore, the evidence seems to vary across subjects. Thus, the present study combines the two motivational constructs domain-specific interests and domain-specific self-concept with the two subjects German (foreign language) and Maths. It pursues the following aims:

1. To check the factorial structure of subject-tied interest and self-concept items, separately and combined.
2. To form subject-specific motivational scales.
3. To compute the intercorrelations of the scales and their relationships to academic achievement.
4. To quantify the shared (common) and non-shared (unique) power of subject-tied interests and self-concepts for the statistical prediction of the corresponding academic achievements, given that all variables are measured at the same level of generality/specificity.

### Method

#### Participants and procedure

The sample comprised $N = 588$ students (age: $M = 15.10$, $SD = 1.71$, $Mdn = 15.00$; 55% girls) stemming from 25 classes of five middle-schools situated of a megacity of China.

The headmasters of the schools and the teachers of the classes provided permission to conduct the survey. Data were collected by a trained psychologist during regular school hours. The survey lasted less than 15 minutes. For group administration purposes, each student was given a questionnaire. The instruction emphasized the anonymity and voluntary nature of participation, as well as the confidentiality of the data. No student refused to take part. Each questionnaire was carefully checked for completion at the time of submission. The answers to inadvertently omitted questions were then made up.

#### Measures

The following data were collected: Biological sex, age, academic performance in German (first foreign language and Maths, the corresponding subject-tied individual interests, and the subject-tied self-concepts. Following Rost et al. (2007), a grid layout was applied to assess the motivational variables. The items were arranged as a table: Each item formed a row and contained a placeholder (...) for the school subject; each of the two school subjects formed a column. Students were asked to mentally fill the placeholder (...) with the topic from the respective column (German; Maths). Students responded to each item on a six-point scale (from “1 not at all true” to “6 fully true”). The items were arranged in a random sequence, the order of the items was the same for all classes. The wordings of the item stems were always parallel for both subjects (see Figure 1). This reduced unwanted variance caused by different item wordings.

Positive experiences with the grid design have been made in various countries with different motivational variables and with different school subjects (Baudson et al., 2017; Feng, 2019; Feng et al., 2015; Sparfeldt et al., 2005, 2015; Sparfeldt & Rost, 2011). Furthermore, previous research had compared a block-wise presentation of items with the layout of a traditional questionnaire and had found comparable factorial structures and comparable psychometric properties (Rost & Hoberg, 1997; Sparfeldt et al., 2006). Interest items and self-concept items were translated according to the procedure suggested by Brislin.
(1970). A bilingual advanced psychology student translated the items from German into Chinese. A lecturer for German studies at a Chinese University translated them back into German. No noteworthy discrepancies emerged in the formulations of the items.

**Interests and self-concepts**

The students rated the “interestingness” of the school subjects German and Maths using five items of the Interest Grid developed by Sparfeldt et al. (2004). The items focused on the cognitive and emotional components of individual (habitual) interest (examples: Figure 1, second and third item). Previous research has shown that different subject-specific interests could be reliably (Cronbach’s α ≥ .93) measured with the original scales of the Interest Grid. Its scales displayed good convergent and discriminant validities with school report marks (Sparfeldt et al., 2004; Rost et al., 2007).

The self-concepts of German and Maths were measured with five items each which were taken from the Differential Self-Concept Grid (Rost et al., 2007). For item examples, see Figure 1, first and fourth item. Good internal consistencies (α ≥ .93), satisfying test-retest reliabilities (r ≥ .82, six weeks), and convincing convergent and divergent validities have been reported by several studies in different eastern and western cultural settings (e.g. Feng, 2019; Rost et al., 2007).

**Age, sex, and academic achievements**

The students were asked to write down their age, sex, and their received credit points (last school report) for the subjects German (first foreign language) and Maths. Studies have shown that school marks and achievement test scores are highly predictive of success in school, college, and career. They determine the future fate of students’ lives (Hell et al., 2008; Schuler & Schult, 2018; Trapmann et al., 2007; Tent & Birkel, 2010; Velten & Schitzler, 2011) and are thus ecologically valid.

Research has repeatedly revealed extremely high correlations between self-reported and actually received achievement indicators (credit points, school report marks, achievement test scores, see Cole & Gonyea, 2010; Feng & Rost, 2015; Kuncel et al., 2005; Sparfeldt et al., 2008; Schneider & Sparfeldt, 2016). Sticca et al. (2017, p.3) summarized the state of the knowledge as follows: “All studies have found self-reported grades to be reliable indicators of actual grades ... [and] generally predict outcomes to a similar extent as actual” ones.

**Data treatment**

The current sample size is sufficient for both manifest and latent correlation analyses and thus for confirmatory analyses (CFAs), provided that the postulated models are not very complex (cf. Koran, 2016, 2020; Myers et al., 2011), as well as for well-powered regression-based analyses (Urban & Mayerl, 2018).

Data analyses were done with IBM SPSS 25 / IBM AMOS 25. Within each class, all items and all report card points were z-standardized which transformed these variables into a common metric with \( M = 0.00 \) and \( SD = 1.00 \). Product-moment correlations were calculated. Correlations were averaged using Fisher’s z-transformation. A series of CFAs (maximum likelihood estimation) were run to compare competing and theoretically grounded models, allow-
The next four models tested the discriminant construct (we accepted correlated measurement errors for items-stems with identical wordings – only the name of the school subject differed).

1. The following four CFAs, each with five subject-specific items, were conducted: Model 1 – interest German, model 2 – interest Maths, model 3 – self-concept German, and model 4 – self-concept Maths. Theses models proved whether the theoretically postulated uni-dimensionality of each of the two interest scales and each of the two self-concept scales was actually given.

2. Each of models 5 to 8, which were subsequently tested, comprised ten subject-specific items: Model 5 assumed a general interest factor that fused the five interest German indicators with the five interest Maths indicators. Model 7 assumed a general self-concept factor that fused the five self-concept German indicators with the five self-concept Maths indicators. These single-factor models were contrasted with alternative models, each consisting of two subject-specific factors. Model 6 assumed two interest factors, one interest German factor and one interest Maths factor indicated by five items each. Model 8 analogously hypothesizes two subject-specific self-concept factors, namely one self-concept German factor and one self-concept Maths factor (each factor indicated by five items).

3. Each of model 9 to model 12 comprised ten subject-specific items: Model 9 postulated a general German factor (fusing all German items), model 11 a general Maths factor (fusing all Maths items). Model 10 postulated two German factors, namely one self-concept German factor (indicated by five self-concept German items) and one interest German factor (indicated by five interest German items). Similarly, model 12 postulated two Maths factors, one self-concept Maths factor and one interest Maths factor, with each factor indicated by five items.

4. The next four models tested the discriminant construct validity of interests and self-concepts when all twenty subject-specific items were jointly factorized: Model 13 assumed one broad general motivational factor. Model 14 tested two subject factors, one German0 factor and one Maths factor. Model 15 hypothesized two construct factors, one interest factor and one self-concept factor. Finally, the theoretically most sound model 16 postulated four separate motivational factors, namely interest German, interest Maths, self-concept German, and self-concept Maths. Each of the four factors are indicated by the corresponding five subject-specific items (see Figure 2).

The fit index chi-square is known to depend heavily on the sample size. Larger samples will almost always produce a statistically significant chi-square even if the model fits very well. Therefore, goodness of fit of each model was evaluated using the absolute fit indices \( \chi^2 / df \), \( \text{Root Mean Square Error of Approximation} \) (RMSEA, with 90% CI), and \( \text{Standardized Root Mean Square Residual} \) (SRMR), together with the incremental Tucker-Lewis Index (TLI). The following fit criteria were applied to determine a good (acceptable) model fit: \( \chi^2 / df \leq 3.0 \) (\( \leq 5.0 \)), TLI \( \geq 0.95 \) (\( \geq 0.90 \)), RMSEA \( \leq 0.06 \) (\( \leq 0.08 \)), and SRMR \( \leq 0.06 \) (\( \leq 0.10 \)).

Note that these cut-off criteria are merely rules of thumb which “should not be taken too seriously” (Schermelleh-Engel et al., 2003, p.52). We considered the complete pattern of fit indices as important for evaluating model fit. Competing models were compared applying the Akaike Information Criterion (AIC, Akaike, 1987) which can be used in a the maximum likelihood estimation. A numerically smaller AIC indicates a better-fitting model.

Based on the CFAs, psychometric scales were formed by summing up the selected numbers of the respective assigned items. Higher scores indicated higher levels of interest and self-concepts. Psychometric scale properties were calculated. We used raw values for calculating \( M \) and \( SD \), and \( z \)-standardized scores for all other statistical methods. The intercorrelations of the scales and their power for the statistical prediction of the credit points were determined. We run commonality analyses, a special variant of multiple regression (Zientek & Thompson, 2006; Ozbudemir, 2015; Nimon & Oswald, 2016; Ray-Mukherjee et al., 2014), to quantify the shared (common) and non-shared (unique power of each scale in predicting students’ academic achievement in the corresponding subject (first second language German, and Maths)). Collinearities were checked by variance inflation factors (VIF).

**Results**

**Factorial structures**

Table 1 shows the results of the 16 CFAs which were run. For both subjects (German and Maths) Maths), the one-dimensionality of the interest items and self-concept items could be supported (model 1 to model 4). The variance explained by each of the four general factors ranged from 76.0% (model 1) to 84.0% (model 2), the standardised loadings of the indicators on each factor were very high throughout (\( \lambda_{\min} = .75, \lambda_{\max} = .95 \)).

The next four CFAs examined the dimension(s) that arose when the ten interest items (five for each subject: model 5, model 6) on the one hand and the ten self-concept items (five for each subject: model 7, model 8) on the other hand were jointly factorized. Models which postulated a general motivational dimension (model 5, model 7) displayed a misfit. Instead, two interest and two self-concept factors with consistently high item loadings (\( \lambda_{\max} = .75, \lambda_{\max} = .95 \)) showed...
a satisfying fit (model 6: interest German; interest Maths; model 8: self-concept German; self-concept Maths).

For evaluating model 9 to model 12, we analysed the ten items related to the same school subject. Again, subject-specific general factors amalgamating the interest and self-concept indicators (model 9, model 11) were inappropriate. Instead, one interest and one self-concept factor per school subject (model 10, model 12; $\lambda_{\text{min}} = .75, \lambda_{\text{max}} = .95$) was supported.

Model 13 to model 16 were indicated by all twenty items. Neither a broad general factor model (model 13) nor a model with two subject factors (model 14) or a model with two construct factors (model 15) fitted satisfactorily. Model 16 with four motivational factors – two interest dimensions (interest German; interest Math) and two self-concept dimensions (self-concept German and self-concept Maths) – fitted very well. Each item was highly indicative of its postulated factor (smallest loading: $\lambda_{\text{min}} = .73$; highest loading: $\lambda_{\text{max}} = .94$).

### Table 1. Factorial structures of subject-tied interests and subject-tied self-concepts

<table>
<thead>
<tr>
<th>Model</th>
<th>$\chi^2$ / df</th>
<th>TLI</th>
<th>SRMR</th>
<th>RMSEA [90% CI]</th>
<th>AIC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicators: 5 items interest German</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Model 1: One factor: Int German</td>
<td>4.70</td>
<td>0.98</td>
<td>.02</td>
<td>.08 [.05, .11]</td>
<td></td>
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<tr>
<td>Model 2: One factor: Int Maths</td>
<td>2.97</td>
<td>0.99</td>
<td>.01</td>
<td>.05 [.02, .08]</td>
<td></td>
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<tr>
<td><strong>Indicators: 5 items self-concept German</strong></td>
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<tr>
<td>Model 3: One factor: S-c German</td>
<td>1.60</td>
<td>0.99</td>
<td>.01</td>
<td>.03 [.00, .07]</td>
<td></td>
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<tr>
<td><strong>Indicators: 5 items self-concept Maths</strong></td>
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<tr>
<td>Model 4: One factor: S-c Maths</td>
<td>1.88</td>
<td>0.99</td>
<td>.01</td>
<td>.04 [.00, .08]</td>
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<tr>
<td><strong>Indicators: 5 items interest German and 5 items interest Maths</strong></td>
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<tr>
<td>Model 5: One factor: Int</td>
<td>45.87</td>
<td>0.58</td>
<td>.23</td>
<td>.28 [.27, .29] 1577.86</td>
<td></td>
</tr>
<tr>
<td>Model 6: Two Int factors: F1: Int German; F2: Int Maths</td>
<td>3.03</td>
<td>0.98</td>
<td>.04</td>
<td>.06 [.05, .07] 158.02</td>
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<tr>
<td><strong>Indicators: 5 items self-concept German and 5 items self-concept Maths</strong></td>
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<tr>
<td>Model 7: One factor: S-c</td>
<td>68.59</td>
<td>0.48</td>
<td>.28</td>
<td>.34 [.33, .35] 1577.86</td>
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<tr>
<td>Model 8: Two S-c factors: F1: S-c German; F2: S-c Maths</td>
<td>1.89</td>
<td>0.99</td>
<td>.02</td>
<td>.04 [.02, .06] 158.02</td>
<td></td>
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<tr>
<td><strong>Indicators: 5 items interest German and 5 items self-concept German</strong></td>
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<tr>
<td>Model 9: One factor: German</td>
<td>19.19</td>
<td>0.85</td>
<td>.07</td>
<td>.18 [.16, .19] 694.35</td>
<td></td>
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<tr>
<td>Model 10: Two German factors: F1: Int German; F2: S-c German</td>
<td>5.25</td>
<td>0.97</td>
<td>.03</td>
<td>.08 [.07, .09] 234.22</td>
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<tr>
<td><strong>Indicators: 5 items interest Maths and 5 items self-concept Maths</strong></td>
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<tr>
<td>Model 11: One factor: Maths</td>
<td>12.47</td>
<td>0.89</td>
<td>.04</td>
<td>.14 [.13, .15] 475.79</td>
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<tr>
<td>Model 12: Two Maths factors: F1: Int Maths; F2: S-c Maths</td>
<td>3.67</td>
<td>0.97</td>
<td>.02</td>
<td>.07 [.06, .08] 183.54</td>
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<tr>
<td><strong>Indicators: 5 items interest German, 5 items interest Maths, 5 items self-concept German, and 5 items self-concept Maths</strong></td>
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<tr>
<td>Model 13: One factor: Int+S-c</td>
<td>34.66</td>
<td>0.46</td>
<td>.29</td>
<td>.24 [.23, .25] 5555.13</td>
<td></td>
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<tr>
<td>Model 14: Two subject factors: F1: Int German+S-c German; F2: Int Maths+S-c Maths</td>
<td>9.04</td>
<td>0.87</td>
<td>.06</td>
<td>.12 [.11, .12] 1552.02</td>
<td></td>
</tr>
<tr>
<td>Model 15: Two construct factors: F1: Int German+Int Maths; F2: S-c German+S-c Maths</td>
<td>30.52</td>
<td>0.53</td>
<td>.27</td>
<td>.22 [.22, .23] 4880.98</td>
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</tr>
<tr>
<td>Model 16: Four factors: F1: Int German; F2: Int Maths; F3: S-c German; F4: S-c Maths</td>
<td>2.80</td>
<td>0.97</td>
<td>.03</td>
<td>.05 [.04, .06] 580.90</td>
<td></td>
</tr>
</tbody>
</table>

Note: $N = 588$. All items were classwise z-standardized.

F = factor; Int = interest; S-c = self-concept; AIC = Akaike Information Criterion; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; TLI = Tucker-Lewis Index.
Table 2. Psychometric properties of the scales measuring subject-tied interests and subject-tied self-concepts

<table>
<thead>
<tr>
<th>Psychometric property</th>
<th>Interest German</th>
<th>Interest Maths</th>
<th>Self-concept German</th>
<th>Self-concept Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of items</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Minimal score*</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Maximal score*</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Mdn *</td>
<td>18</td>
<td>18</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>M*</td>
<td>20.82</td>
<td>21.31</td>
<td>17.46</td>
<td>19.11</td>
</tr>
<tr>
<td>SD*</td>
<td>6.84</td>
<td>7.10</td>
<td>6.93</td>
<td>6.79</td>
</tr>
<tr>
<td>Mean $r_{i(i)}$</td>
<td>.78</td>
<td>.82</td>
<td>.85</td>
<td>.84</td>
</tr>
<tr>
<td>$\phi$</td>
<td>.92</td>
<td>.93</td>
<td>.95</td>
<td>.94</td>
</tr>
<tr>
<td>Skewness*</td>
<td>-0.46</td>
<td>-0.60</td>
<td>-0.12</td>
<td>-0.20</td>
</tr>
<tr>
<td>Kurtosis*</td>
<td>-0.72</td>
<td>-0.63</td>
<td>-0.98</td>
<td>-0.95</td>
</tr>
</tbody>
</table>

Note: $N = 588$. Mean $r_{i(i)} = \text{averaged part-whole corrected item discrimination index}$. *Raw scores; all items were classwise converted to z-scores.

Table 3. Intercorrelations of subject-tied interests and subject-tied self-concepts (upper right triangular matrix: Scales; lower left triangular matrix; italics: Factors)

<table>
<thead>
<tr>
<th>Interest German</th>
<th>Interest Maths</th>
<th>Self-concept German</th>
<th>Self-concept Maths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest German</td>
<td></td>
<td>.31</td>
<td>.76</td>
</tr>
<tr>
<td>Interest Maths</td>
<td>.29</td>
<td></td>
<td>.21</td>
</tr>
<tr>
<td>Self-concept German</td>
<td>.81</td>
<td>.22</td>
<td></td>
</tr>
<tr>
<td>Self-concept Maths</td>
<td>.17</td>
<td>.82</td>
<td></td>
</tr>
</tbody>
</table>

Note: $N = 588$. All items were classwise z-standardized. Bold = convergent correlations. All coefficients differ statistically from zero ($p < .01$).

Psychometric scale properties

Two subject-tied interest scales and two subject-tied self-concepts scales were formed. Their psychometric properties are listed in Table 2. Univariate normality was not severely violated. The internal consistencies (Cronbach’s $\phi$) of all four scales were high and of comparable size to those of the longer original scales, each consisting of eight items (cf. Rost et al., 2007; 2008; Sparfeldt et al., 2004; Buch et al., 2019).

Scale intercorrelations

All four scales were positively related. Due to the high scale reliabilities (minimal $\phi = .92$), the intercorrelations of the factors were very similar to those of the scales (Table 3). Scales and factors addressing the same school subject displayed substantially larger correlations than scales and factors addressing different subjects (scales: $r_{\phi} = .77$ vs. $r_{\phi} = .23; p < .001$; factors: $r_{\phi} = .82$ vs. $r_{\phi} = .24; p < .001$). The school subject did not moderate the high convergent relations of interests with self-concepts ($p > .10$).

Statistical prediction of academic achievement

The credit points in German and Maths and the four motivational scales were positively related ($p < .01$; exception: a negligible association of achievement in German with interest in Maths, $r = .07$; see Table 4). Addressing the same subject always yielded a higher motivation-achievement correlation than addressing a different subject (averaged convergent correlation: $r_{\phi} = .49$; averaged divergent correlation: $r_{\phi} = .15$). The two interests scales correlated significantly less with associated academic achievement than did the two self-concept scales.

Due to the high correlations between self-concept scales referring to the same subject, a collinearity check was performed. The maximal association between the motivational variables (which served as predictors for the commonality analyses) was $r = .78$, thus below the critical threshold of $r \geq .90$ (Jonas & Ziegler, 1999). The variance inflation factors were VIF$_{\text{German}} = 2.38$ and VIF$_{\text{Maths}} = 2.56$, thus also below the critical threshold of 5.00 (Urban & Mayerl, 2018). The validities of the commonality analyses were therefore not seriously affected by excessive collinearities.
Correlated predictors share a certain amount of criterion variance. Hierarchical regression analyses cannot separate unique criterion variance from confounded variance. However, commonality analysis can quantify the specific contribution that each predictor and the combinations of predictors make to the regression effect. If two predictors are used, the criterion variance accounted for can be split into three parts: variance that is unique (non shared) to the first predictor, variance that is unique (non shared) to the second predictor, and variance that is common (shared) to both predictors.

Table 5 displays the results of the commonality analyses. Much more achievement variance could be accounted for in German (41.0%) than in Maths (22.3%). The confounded proportion of explained achievement variance was greater in German (19.8%) than in Maths (12.4%). It turned out that the remaining amount of explained variance was fully attributable to the subject-tied self-concepts and not to the subject-tied interests. Due to the very high scale reliabilities (cf. Table 2), commonality analyses which were based on factor scores led to essentially identical results.

**Table 5. Commonality analyses: Subject-tied academic self-concepts and subject-tied interests predicting associated credit points of the recent school report**

<table>
<thead>
<tr>
<th>Predictor (scale)</th>
<th>Explained variance</th>
<th>Proportion of explained variance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Shared</td>
</tr>
<tr>
<td>Credit points German</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest German</td>
<td>41.0%</td>
<td>19.8%</td>
</tr>
<tr>
<td>Self-concept German</td>
<td></td>
<td>20.9%</td>
</tr>
<tr>
<td>Credit points Maths</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interest Maths</td>
<td>22.3%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Self-concept Maths</td>
<td></td>
<td>9.8%</td>
</tr>
</tbody>
</table>

Note: N = 588. All items were classwise z-standardized.

On the one hand, it confirmed previous findings and, on the other hand, shed additional light on the predictive power of interest and self-concept on adolescents’ academic performance. With more than 500 Chinese adolescents, the sample was well sized. The investigated subjects were the first foreign language German (verbal domain) and Maths (numerical domain). In order to replicate and extend previous research findings we undertook four steps:

1. The factorial structure of each construct and of their combinations were checked.
2. Based on this, four subject-tied motivational scales were formed (interest German, interest Maths, self-concept German, self-concept Maths). Their psychometric properties were established.
3. The intercorrelations of these four scales and their associations with credit points in German and Maths were analysed.
4. The major contribution was probing the shared (common) vs. non-shared (unique) explained variance in academic achievement accounted for by interests and self-concepts. This was done via commonality analyses which quantified the shared and non-shared (unique) power of the scales for the prediction of school credit points.

The results are remarkably clear. Each motivational scale proved to be one-dimensional. Furthermore, two correlated motivational factors (interest; self-concept) could be confirmed within each subject (German; Maths). Two subject factors (German; Maths) emerged within each subject.

**Discussion**

This study examined the common structure of two subject-specific interests and two subject-specific self-concepts.
Nevertheless, their internal consistencies were high of test-criterion correlations” (Michel et al., 2020, p. 1–2).

Each motivational scale consisted of only five items. Nevertheless, their internal consistencies $\alpha$ were high ($\alpha_{\text{min}} = .$. The four motivational constructs showed convincing convergent-divergent validities. There was a large overlap in the variances of the interest and self-concept scales tied to the same subject (see also Köller et al., 2019; van der Westhuizen, 2022). Each motivation scale was positively related to the associated school credit points. Validity coefficients were remarkably lower for interests than for self-concepts. This is a finding that has been reported more than once (e.g. Corbière et al., 2006; Gogol et al., 2017; Köller et al., 2019). Taken together, both scales together (interest and self-concept) explained more achievement variance in German (41%) than in Maths (22%), showing that in educational settings various motivational and emotional constructs are closely tied to scholastic contents (e.g. Arens et al., 2019; Baudson et al., 2017; Feng, 2019; Goetz et al., 2006; Jansen et al., 2016; Keller et al., 2019; Lauermann et al., 2020; Sparfeldt et al., 2015).

The analysis of the specifics of the two motivational constructs for explaining achievement variance was of special relevance. Both interests had no unique predictive power. In contrast, each of both self-concepts had a considerable unique power for the statistical prediction of the corresponding credit points of the last school report. Interests were thus irrelevant for the statistical prediction of subject-tied scholastic achievement in the subjects German (first foreign language) and Maths after controlling for the associated self-concepts. Thus, if one wants to predict school credit scores or marks by motivational variables, it seems unnecessary to assess subject-tied interests if one also intends to measure the matched self-concepts. However, the other way around does not apply: Assessing subject-bound interests does apparently not eliminate the need to measure the corresponding subject-bound self-concepts.

The results of our study provide additional insight into the interplay of academic interests and academic self-concepts in the statistical prediction of scholastic achievement assessed via school credit points. Replications are needed because of the small amount of available research on the common (shared) and unique (non-shared) power of subject-tied interests and subject-tied self-concepts for explaining performance in different school subjects.

The shortness of the scales, combined with the grid layout, makes them particularly suitable for use in large-scale projects if many psychological variables are collected and if the administration time is short. Note that the grid display can be easily modified or extended by other school subjects (Schilling et al., 2004).

Our study has some limitations that may have implications for future research. The sample consisted of Chinese adolescents. This may constrain the generalisability of the results. Most Chinese youth learn “not only for themselves and their lives but for the status and prestige of the family” (Baron & Yin-Baron, 2019, p.135). Their motivation for achievement seems to be less intrinsically oriented than that of young people from Western cultures. This may also have contributed to the negligible specificity of interests concerning the statistical prediction of school credit points. Future studies should examine whether interest has stronger predictive power for academic achievement if school subjects can be chosen voluntarily.

Furthermore, we examined only two major subjects, the first foreign language German as representative of the verbally oriented and Maths as representative of the numerically oriented subjects. The reported results are in line with the findings of earlier studies on the importance of interests and self-concepts in predicting scholastic achievement. Nevertheless, it would be useful to examine other school subjects as well, including minor subjects. The use of other questionnaires may lead to different results. The same applies to the use of standardized achievement tests instead of school grades.

Motivation and performance are reciprocally related. The design of our study did not control for prior subject-specific achievement on the one hand and general intelligence on the other hand. Both variables are widely known to be strong predictors of academic achievement (e.g. Jensen, 1988; Rost, 2013; Schneider & Preckel, 2017). Research has shown that motivational variables still have incremental validity for explaining academic achievement after controlling for intelligence (e.g. Lauermann et al., 2020). Notwithstanding, the specific power of self-concepts to statistically predict school credit points may have been somewhat overestimated in our study.

The present cross-sectional study does neither allow causal statements nor the analysis of developmental trends. A multi-annual longitudinal study covering a wide range of ages would be required to provide clarity on this topic, especially to figure out in detail the complex interplay of subject-tied motivational concepts with achievement (skill development – self-enhancement). Even more compelling would be experimental studies examining the extent to which subject-specific self-concept trainings can
Both constructs – positive self-concepts and enduring interests – should address these topics. Last but not least: being at school should not be underestimated. Future associated interests will increase. This, in turn, may have a positive effect on academic performance – more precisely, in predicting credit points of the last school report. Interests, subject-tied interests, and subject-tied self-concepts (see Badewitz et al., 2021). This, in turn, may have a positive effect on academic performance in the associated subjects. Given the strong association of interests with self-concepts, this strategy might perhaps increase the likelihood that the associated interests will increase.

Finally, beyond the achievement aspect, the role of interests for students’ general learning behaviour and well-being at school should not be underestimated. Future studies should address these topics. Last but not least: Both constructs – positive self-concepts and enduring interests – are considered as relevant psychological and educational outcomes in their own right.

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Conflict of Interest

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