Multistudy Report

The Development and Validation of an Interest and Skill Inventory on Educational Choices (ISEC)

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Abstract: This study aimed at developing and validating a new instrument to facilitate late adolescents and young adults to choose a higher education major. For the main study, the sample consisted of 6,215 late adolescents and young adults (M_{age} = 19.50, SD = 1.89, 42.3% female). After rational scale construction based on the RIASEC model of Holland (1997), several statistical analyses were conducted. In four studies, structural validity, internal consistency, and construct validity were examined. Our analyses showed that adequate structural validity, internal consistency, and construct validity were established. A 7-factor structure was found, in which the investigative domain split into two subscales. The overall results suggested that the new instrument is reliable and valid as an orientation instrument in applied settings in secondary and higher education.

Keywords: Interest and Skill Inventory, educational choice, Holland's RIASEC types, scale development, higher education

When pupils choose an undergraduate program that does not align with their interests, they are more likely to drop out of higher education (Quinn, 2013). The problem is that many pupils following secondary education have difficulties defining their interests and choosing a suitable bachelor's program. These difficulties eventually can lead to drop-out (Van Bragt, Bakx, Teune, & Bergen, 2011). Therefore, helping pupils in secondary education to explore these interests can improve congruence between pupils' interests and their chosen program (Tracey & Robbins, 2006) and thus retention rates at universities. Existing measures for determining students' interests satisfy important psychometric criteria, like structural validity and reliability. However, many measures draw heavily on job titles (e.g., the Interest profiler; Armstrong, Allison, & Rounds, 2008), which may not yet be relevant for a 17-year-old. Furthermore, most existing measures have been developed and validated in the US. Cross-cultural applications of interest measures are not always without problems (Einarsdóttir, Rounds, Ægisdóttir, & Gerstein, 2002) because educational systems are organized differently across cultural and national boundaries. Finally, most established measures have copyright restrictions, limiting their availability for general utilization.

The current paper describes the development and validation process of a new interest measure that circumvents these issues. Our goals were to develop an instrument that is (1) short and publicly available, (2) suitable for the target group of pupils in secondary education who contemplate their next educational choice, and (3) suitable for the contemporary context of Dutch secondary and tertiary education.

A New Interest Measure

Although the theory originated in the previous century, citations to Holland's work have continued to climb in the current century (Kennelly, Sargent, & Reardon, 2018). This suggests that Holland's contributions continue to impact theory and practice in educational and vocational research. Holland's person–environment fit theory (Holland, 1985) is best known as a theory of occupational selection that proposes that people prefer work or educational environments that match their personal interests (Wille & De Fruyt, 2014). When a person's interests are congruent with his or her environment, the theory predicts that this will

lead to higher performance (e.g., higher retention rates, Tracey & Robbins, 2006).

According to this theory, personal interests as well as environments can be classified by six types, that is, the Realistic, Investigative, Artistic, Social, Enterprising, and Conventional type (for a description of these types, see Nye, Su, Rounds, & Drasgow, 2012). Scores on these types together create a RIASEC-profile (the acronym of the beginning letter of each interest). Holland's model represents the six types in a hexagon (see Figure 1). Figure 1 superimposes a circumplex onto the hexagon, which has the advantage that the interest types can be described by their angular locations. In a strict hexagon structure, the angle between adjacent interests is 60° and 180° (i.e., opposite) between interests that are most dissimilar (Holland, 1973). Holland later proposed a less restrictive model, a quasi-circumplex, in which the angles between adjacent types do not need to be equal (Guttman, 1954).

A variety of RIASEC measures are available through test publishers and the US Department of Labor (Armstrong et al., 2008). For example, in their review of measures, Armstrong and his colleagues (2008) listed the Unisex Edition of the ACT Interest Inventory (UNIACT, ACT, 1995), the Strong Interest Inventory (SII, Donnay, Thompson, Morris, & Schaubhut, 2004), the Self-Directed Search (SDS, Holland, Fritzsche, & Powell, 1997), and the O*NET Interest Profiler (Lewis & Rivkin, 1999), of which the SII, SDS, and UNIACT are the most frequently used. Other researchers have developed interest measures that are available on the internet, such as the Personal Globe Inventory (PGI; Tracey, 2002). All these inventories ask participants to describe their interests and self-perceived skills for each of the RIASEC types. The former measures the underlying reasons for choosing an educational domain (Pintrich, Marx, & Boyle, 1993). The latter measures a person's beliefs about his or her capabilities to perform well in that domain. The likelihood that a person chooses a certain educational domain increases when that person scores high on both scales. If there would be a large discrepancy between the two, a study counsellor might point out other suggestions to the student that fit better to the level of the student's interests and skills. Thus, it is important to distinguish between these two types of questions within interest inventories.

Although many interest inventories exist already, there are several reasons for developing new educational orientation instruments. These reasons are presented below and are the criteria on which we compare some of the existing inventories mentioned above (see Table 1). As can be seen, none of the current measures (1) fit to our target group of 17-year-olds, (2) are designed for the Dutch population, and (3) are freely available. In the following, the necessity for additional scale development is described in terms of each of these three limitations.

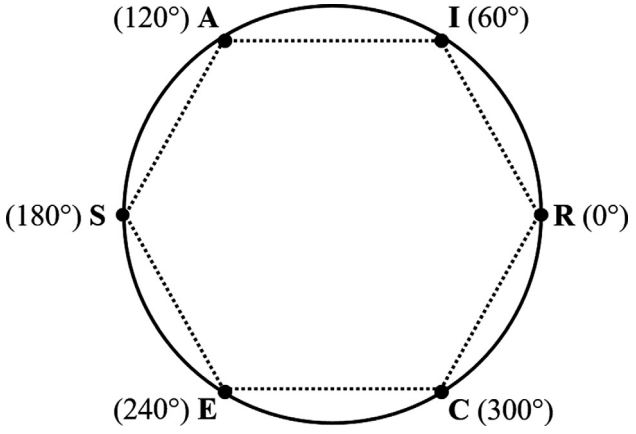

Figure 1. Graphical representation of Holland's hexagon model (dotted lines) and its representation as a perfect circumplex (solid lines).

First, many pupils in secondary education likely have a limited understanding of how the world of work is organized. Therefore, it can be difficult for them to self-report on vocational interests through preferences for job tasks or occupational titles. However, the inventories that are listed in Table 1 (see the criterion "target group") contain items that do not relate to the lives of 17-year-olds (e.g., "I (dis)like to buy and sell stocks and bonds"). In order to map pupils' interests, it is thus essential that inventories include items related to activities that are prevalent in their lives.

Second, most inventories have been developed and validated in the US and do not specifically meet the Dutch contemporary context (see the second criterion "context" in Table 1). For example, in more feminine cultures like the Dutch culture (Hofstede, 1991), people face fewer barriers to vocational choice because of less restrictive gender roles than in more masculine cultures (Rounds & Tracey, 1996). Furthermore, the educational system in The Netherlands is different from the US and many other countries. Dutch pupils have to decide on a vocational direction in the second half of their secondary education period. There are four study profiles, developed to give pupils a better preparation for the sectors in which society is divided, that is, science and technology (science profile), science and health (health profile), economics and society (economy profile), and culture and society (culture profile). The choice of one of these four profiles is mainly based on students' interests and skills. Once they enter university, students select their university majors right away, and typically do not switch majors at a later stage as in the US. In other words, Dutch students have to specialize quite early in their educational trajectory. Given the differences between cultures as well

Table 1. Some examples of Holland interest inventories

Measure	Target group[g]	Context[h]	Open source[i]
HZO[a]	✗	US (translated)	✗
O*NET IP[b]	✗	US	✓
PGI-Short[c]	✗	US	✓
SDS[d]	✗	US	✗
SII[e]	✗	US	✗
UNIACT[f]	✗	US	✓

Note. [a]Hollands Zelfonderzoek (Platteel & Uterwijk, 2008). [b]O*NET Interest Profiler Short Form (Rounds, Su, Lewis, & Rivkin, 2010). [c]Personal Globe Inventory Short (Tracey, 2010). [d]Self-Directed Search (Holland & Messer, 2013). [e]Strong Interest Inventory Revised (Donnay et al., 2004). [f]The Unisex Edition of the ACT Interest Inventory (American College Testing, 2009). [g]Most of the items were written for 16–25-year-olds. [h]The context in which the inventory was developed. [i]Whether the inventory is open source or not (no open source means that the pupil has to pay). ✓ = criterion is present, ✗ = criterion is not present.

as educational systems, a different latent structure of interests may exist in The Netherlands. For example, Wille, De Fruyt, Dingemanse, & Vergauwe (2015) have noted that the six RIASEC scales may include sub-factors. Specifically, these authors suggested that the social interest type consists of two components: a "social-care" component (helping and taking care of others) and a "social-education" component (stimulating the personal development of others).

Third, most inventories fall under copyright restrictions of test publishers (Armstrong et al., 2008) and are not publicly available (the third criterion in Table 1). This is a constraining factor for secondary education pupils on the verge of selecting a study program. Ideally, secondary education students have free access to reliable and validated interest inventories, encouraging students to explore their interests.

Goals of the Study

The main goal of the present study was to develop and validate a short and publicly available instrument for pupils in secondary education that are about to choose an undergraduate program in the contemporary Dutch context. The three research questions addressed in this study were:

Research Question 1 (RQ1): What factor structure underlies responses to the instrument and is this structure invariant across gender?

Research Question 2 (RQ2): Are the subscales internally consistent and do the subscales yield the same results on repeated trials (test–retest reliability)?

Research Question 3 (RQ3): Does the instrument measure what it is supposed to measure (convergent and discriminant validity)?

Figure 2 explains the sequence of studies and how item development and the validation of these items (Study 1) led to the final ISEC items in Study 2. The figure also informs about which research question is answered by what study and the corresponding methods and sample sizes. Moreover, to conduct the test–retest reliability analyses in Study 3, a subsample of Study 2 was used.

Regarding RQ1, we expected that the factor structure would resemble the RIASEC structure, possibly with subfactors due to the differences in cultural and educational context, as Wille et al. (2015) suggested. For RQ2 and RQ3, we applied the following criteria. Regarding RQ2, we used the criterion that the internal consistencies and the 1-month test–retest reliabilities of the RIASEC scales should be at least 0.7 (Kline, 2000). With regard to the effect sizes of the differences between the scales at Time 1 and Time 2, we considered a Cohen's $d < .2$ to be appropriate. Regarding RQ3, we compared our instrument with two instruments that were developed in the US: the Personal Globe Inventory Short (PGI-Short) and the SDS. With respect to convergent validity, we expected substantial positive correlations with corresponding scales of the other two instruments (e.g., between the artistic scale of our instrument and the same scale of the SDS). With respect to discriminant validity we expected weak or no

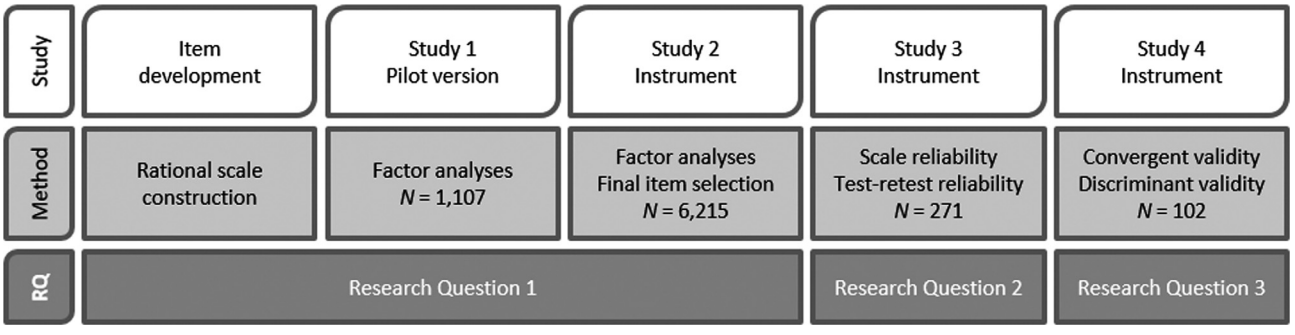

Figure 2. Flowchart of the four studies.

correlations with dissimilar scales (e.g., between the artistic scale of our instrument and the enterprising scale of the SDS).

Rational Scale Construction

We started with rational scale construction to develop items that tap into interest in activities within each Holland dimension that (prospective) students can relate to. We deliberately sampled activities outside the study setting as well because interests are embedded in and constructed through interaction with different contexts (e.g., Krapp 2002; Renninger & Hidi, 2011). Although school is a very important context, some students are not motivated by school. We therefore sampled activities within and outside the school setting. We aimed to measure two aspects of every activity. First, we aimed to measure whether someone is interested in the activity or not (1 = *completely uninteresting* and 5 = *extremely interesting*). Second, we aimed to measure whether someone feels competent in the activity or not (1 = *I definitely cannot do this* and 5 = *I can do this extremely well*). This distinction was inspired by the expectancy-value theory of Eccles (1983). This theory argues that an individuals' choice to pursue an activity (e.g., a field of study) can partly be predicted by the extent to which the individual values the activity (his/her interest) and the individual's belief of whether he/she is competent for an activity (self-perceived skill; Wigfield & Eccles, 1992). However, it is unclear which of the two (interests or self-efficacy) is the better predictor for outcome variables (e.g., Walker, Greene, & Mansell, 2006; Girelli et al., 2018).

Two experts were instructed to write down activities for each of the Holland types, resulting in an initial pool of 66 daily activities. These 66 items were assessed by a group of 18 pupils belonging to the intended target group (50.0% female, M_{age} = 19.6, SD = 2.85). We asked them on a Likert scale ranging from 1 (= *completely disagree*) to 5 (= *completely agree*) whether the items were clear to them and whether they could identify themselves with the proposed activities. Subsequently, the items were submitted to eight vocational experts (vocational interest assessment professionals, career counseling experts, or academic scholars), who rated from 1 (= *completely disagree*) to 5 (= *completely agree*) whether items were adequately phrased and whether they were clearly representative of one of the Holland types. If this was not the case, we asked for at least three alternative items per interest type. After a series of revisions based on this input, we ended up with 12 items that were unchanged, 48 items that were modified, and 12 new items that were proposed by the experts. This resulted in a list of 12 items per Holland type for the pilot version (i.e., 72 activities).

Study 1: A Pilot Version of the Instrument

In order to answer RQ1 on structural validity, we conducted factor analyses on the pilot version of our instrument.

Method

Participants

The sample of Study 1 consisted of 1,127 applicants who signed up in January 2016 and February 2016 for an undergraduate program at a large University of Applied Sciences in The Netherlands (i.e., higher professional education). As we decided to focus on the specific age group of pupils in secondary education (i.e., late adolescents and young adults), we did not use the data from applicants older than 25 years (1.8%), resulting in a sample of 1,107 participants (68.1% female) aged between 16 and 25 years (M_{age} = 19.04, SD = 1.78). They filled out an online questionnaire as part of the intake procedure at this university.

Measure

The pilot version of our instrument measured interests and self-perceived skills. For each of the 72 activities, participants indicated whether they found it interesting and whether they felt skilled at engaging in them. The response format ranged from 1 (= *completely uninteresting/definitely cannot do this*) to 5 (= *extremely interesting/I can do this extremely well*). Hence, the instrument consisted of 12 subscales of 12 items each.

Results

Conducting an exploratory factor analysis with Direct Oblimin rotation (using an eigenvalue cut-off of 1) resulted in 13 and 14 factors, explaining 58.13% and 55.87% of the total variance, for interest and skill scales, respectively. When interpreting the results, we carefully looked into what we found in the factor solutions with 13 (interests) and 14 (skills) factors. We clearly found five factors which resembled Holland interest types (R, A, S, E, C). In addition, we found two factors for the investigative type: one capturing activities focused on cultural phenomena (e.g., investigating the history of a specific subject) and one capturing investigative activities that also loaded on the realistic activities factor (e.g., solving a mathematic problem). The remainder of the factors was not interpretable, as they contained just one or a few items. In total, 20 items were eliminated because they did not load on the expected factor or loaded (higher) on another factor. Some scales still consisted of more than eight items. In those cases, we eliminated those items that had the lowest loadings on their main factor.

The second step, consisting of confirmatory factor analyses, resulted in CFI values below the threshold of .90 (.86 for both interest and skill scales) even though the RMSEA values were adequate (.05 for both interest and skill scales). In this analysis we included the selected eight items for all subscales except for the investigative subscales that consisted of five items (after elimination of items according to our previous determined criteria). Finally, reliability analyses resulted in Cronbach alphas (αs) between .77 and .87 for the interest subscales and between .73 and .85 for the skill subscales, which is good.

Conclusion Study 1

In summary, a clear factor structure was established that corresponded to the interest typology of Holland, with the exception of the investigative scale. Regarding the investigative scale, half of its items loaded on a purely investigative factor, whereas the other half also loaded on the realistic factor. In order to interpret this unexpected distribution of factor loadings, we compared all investigative items to the original definition of the investigative type; "Holland's (1997) investigative type prefers activities that entail the observational, symbolic, systematic, and creative investigation of physical, biological, and cultural phenomena in order to understand such phenomena" (Wille et al., 2015, p. 237). Therefore, new items had to be developed to tap into the construct of the investigative type in such a way that these were less activity-oriented (i.e., tapping into the realistic type) and more contemplative or creatively investigative in nature (as emphasized in Holland's definition of the investigative type). Thus, the purpose of the second study was to examine the factor structure of the instrument after including several newly written investigative items.

Study 2: Validation Study

This study was done to check the structural validity of our improved version of the pilot instrument. Two experts developed additional investigative items independently from each other to enhance this specific scale. They made sure that these new items had a science (physical or biological) component and were formulated to tap into creative investigation (e.g., "examining the effect of alcohol on the brain"). Together with a third expert, the same procedure of rating and selecting items was followed as in Study 1, resulting in seven new investigative items.

Study 2 thus set out to conduct some additional validation analyses on the items that were selected in the first study and on the (new) investigative items to see whether these resulted in a reliable and valid investigative subscale. In order to reduce the total number of items, we strove to maintain the six best items per subscale after this validation study.

Method

Participants

The sample of this second study consisted of 6,215 applicants (42.3% female) aged between 16 and 25 years (M_{age} = 19.50, SD = 1.89). They signed up for an undergraduate program at the same university as in Study 1 between April 2016 and September 2016. They filled out an online questionnaire as part of the intake procedure at this university. Applicants signed up for 68 different undergraduate programs in total.

Measure

As in Study 1, the instrument measures two domains: interests and skills. The domain of interests comprised 52 items measuring interests with respect to certain activities. Five of the RIASEC type scales (R, A, S, E, C) consisted of eight items each, except for the investigative scale that consisted of 12 items. For this scale we included four extra items to ensure that enough items would satisfy our psychometric criteria. In Study 2 and the remainder of the studies described below, the RIASEC items were alternately presented (first an R-item, then an I-item and so forth). Furthermore, the interest and skill items were presented twice in two separate columns next to each other. For example, "Caring for a family member" was presented in the left column with a Likert scale of 1 (= *completely uninteresting*) to 5 (= *extremely interesting*) and in the right column with a Likert scale of 1 (= *I definitely cannot do this*) to 5 (= *I can do this extremely well*) for self-perceived skills.

Data Analysis

In order to establish a valid factor structure, exploratory factor analyses with a Direct Oblimin rotation were conducted. During the process of item selection and elimination, we considered four criteria: a high primary factor loading (> .35; Tabachnick & Fidell, 2007), a high item-total correlation, a lack of ceiling effects (as evident from the frequency distributions of responses), and convergence of items with two well-established measures (described in Study 4). Secondly, confirmatory factor analyses in Mplus were conducted to see how well the data would fit a 6-factor structure. Thirdly, to examine whether the final items were invariant across gender, we ran four models suggested by Van de Schoot, Lugtig, and Hox (2012): Model 0 to test for configural invariance, Model 1 to test for metric invariance, Model 2 to test whether the meaning of the levels of the underlying items was equal across gender, and Model 3 to test for scalar invariance. Finally, internal

consistency was examined for all subscales with the chosen items.

Results

Conducting an exploratory factor analysis with Direct Oblimin rotation using an eigenvalue cut-off of 1 resulted in nine factors for both the interest and skill scales, explaining 56.98% and 52.96% of the total variance, respectively. Some of the later factors were not interpretable, however. Based on our four criteria, 14 items were eliminated.

Regarding the 12 items of the investigative subscale, all items (except for one) loaded on the expected investigative factor when conducting an exploratory factor analysis with Oblimin rotation constricted to six factors. However, 5 of the 12 items again double-loaded on other factors. To see whether a simple structure could be achieved, we conducted an additional exploratory factor analysis with Oblimin rotation constricted to seven factors. In this model, none of the items loaded on other factors and the investigative scale split into two sub-factors: one subscale consisted of "humanities" items (which we will call the "investigative-humanities subscale") and one subscale consisted of "natural science" items (which we will call the "investigative-science subscale"). Based on these results, we decided to maintain eight items for the investigate subscale that distinguished between a humanities subscale with four items, and a natural science subscale with four items. The factor loadings of all chosen items of the exploratory factor analysis with Oblimin rotation constricted to six factors are presented in the Electronic Supplementary Material, ESM 1, Appendix A. An exploratory factor analysis without any constrictions resulted in a clear 7-factor structure (see Appendix B in ESM 1).

In the second step, a confirmatory factor analysis in Mplus was conducted to assess the structural validity of the final item set. A 7-factor structure for the interest scales (CFI = .89, RMSEA = .05) fit the data somewhat better than a 6-factor structure (CFI = .88, RMSEA = .06; $\Delta\chi^2 = 826.76$, $p < .001$). Likewise, for the skill subscales, a 7-factor structure (CFI = .91, RMSEA = .04) fit the data somewhat better than a 6-factor structure (CFI = .90, RMSEA = .05; $\Delta\chi^2 = 1{,}146.55$, $p < .001$). Therefore, there was evidence for two separate investigative sub-factors.

We also fitted six and seven exploratory factor models that allowed cross-loadings. This resulted in RMSEAs of .045 and .039 for the 6-factor and 7-factor models, respectively, for the interest scales, and RMSEAs of .044 and .034, for the skill scales. Even though these exploratory factor models result in a better fit than the factor models with simple structures (due to the many more loadings that can be freely estimated), the RMSEAs were only slightly lower. This indicated that the factor models with simple structures fit the data relatively well.

Table 2. Top five undergraduate programs (high to low) based on the average of the two investigative sub-factors (Study 2)

Top 5 investigative-humanities subscale	Top 5 investigative-science subscale
Teacher education in religion	Teacher education in physics
Religious-pastoral studies	Technical physics
Teacher education in sociology	Teacher education in geography
Teacher education in history	Teacher education in biology
Teacher education in geography	Applied science

The RIASEC model of Holland has a circumplex structure where similar types are more strongly correlated than dissimilar types (Rounds & Tracey, 1993). However, statistical analyses using CircE (Grassi, Luccio, & Di Blas, 2010) revealed that the estimated 6-factor model and 7-factor model of the interest and skill subscales did not fit a circumplex structure very well (for more statistical details, see Appendix C in ESM 1).

After the decision to continue with seven subscales, we performed an additional validity check based on the available data. We ranked the top five undergraduate programs according to the students' average scores on the investigative-humanities and the investigative-science subscales. Table 2 shows that students with the highest scores on the investigative-humanities subscales had indeed chosen undergraduate programs with an important humanities component (e.g., Teacher Education in Sociology and Teacher Education in History). Likewise, students with the highest scores on the investigative-science subscales had chosen undergraduate programs with an important natural science component (e.g., Technical Physics and Teacher Education in Biology). This confirms the discriminate validity of the two sub-factors.

In the third step, we conducted multi-group analyses to see whether the final items were invariant across gender. For adequate sample sizes ($N > 300$), Chen (2007) has proposed that a change of $\leq -.010$ in CFI, supplemented by a change of $\leq .015$ in RMSEA, would indicate invariance. Models for configural invariance (Model 0) had a sufficient fit for both interests and skills (CFI = .90, RMSEA = .05 for interests and CFI = .92, RMSEA = .04 for interests) for females as well as males (see Appendix D in ESM 1 for detailed statistics). This means that the pattern of factor loadings did not differ between females and males for interests or skills. When running the subsequent models, only the metric invariance model for interests and the intercept-only models converged. The model of metric invariance for interests had the same fit as the configural

model (CFI = .90, RMSEA = .05). Consistent with the cutoff points of Chen (2007), this suggested that Model 1 was invariant between females and males, meaning that both females and males attributed the same meaning to the latent constructs under study. The fit of the intercept-only models (Model 2) was somewhat lower (CFI = .84, RMSEA = .06 and CFI = .81, RMSEA = .06, for interests and skills, respectively). In line with the cut-off points of Chen (2007), this suggested that Model 2 was noninvariant between females and males, meaning that females interpreted some items differently from men. Overall, we concluded from these analyses that the structure of the instrument was partially genderinvariant (see for all statistical details Appendix D in ESM 1).

Finally, Cronbach's α of the 14 subscales were computed as an indicator of reliability. Table 3 shows that the reliabilities for all subscales were between .71 and .87. Furthermore, the correlations between the interest and self-perceived skill scales were high.

Conclusion Study 2

In summary, the newly developed instrument with a total of 76 items had a 7-factor structure with partial gender invariance. Furthermore, the reliabilities of all subscales were satisfactory to good.

Study 3: Test–Retest Reliability

In order to address another aspect of RQ2, we examined the test–retest reliability of the 76 items that were chosen in Study 2. Vocational interests have been shown to be quite stable dispositional attributes (e.g., Low, Yoon, Roberts, & Rounds, 2005), so a good questionnaire should yield high test–retest correlations at intervals of about a month ($r > 0.7$; Kline, 2000).

Method

Participants

In order to conduct the test–retest reliability analyses, we used a subsample of the sample in Study 2. Applicants of this main sample signed up in April 2016 for an undergraduate program, and were between 16 and 25 years of age. A total of 922 participants were asked to fill out our instrument a second time. Of these applicants, 271 (29.4%) complied with this request (53.5% female, M_{age} = 19.00, SD = 1.84). The time lag between the first and second time these participants filled out the same questions was between 17 days and 50 days (M = 29.0, SD = 7.74).

Table 3. Correlations, means, and reliabilities of all subscales (Study 3)

Subscale	1	2a	2b	3	4	5	6	Interests and skills
1. Realistic	(.77**)	−.00	.46**	.30**	.04**	.03**	.17**	.77**
2a. Investigative-humanities	.01	(.79**)	.37**	.34**	.35**	.33**	.27**	.79**
2b. Investigative-science	.35**	.31**	(.74**)	.29**	.22**	.08**	.18**	.74**
3. Artistic	.28**	.23**	.24**	(.77**)	.28**	.11**	.24**	.77**
4. Social	.05**	.35**	.18**	.26**	(.77**)	.41**	.34**	.77**
5. Enterprising	.09**	.37**	.04**	.17**	.51**	(.76**)	.42**	.76**
6. Conventional	.08**	.26**	.12**	.22**	.28**	.33**	(.59**)	.59**
Mean interests (total)	2.82 (0.85)	3.58 (0.74)	2.92 (0.86)	3.06 (0.87)	3.72 (0.66)	3.63 (0.59)	3.23 (0.65)	
Mean interests (male)	2.99 (0.83)	3.51 (0.75)	2.99 (0.85)	2.83 (0.82)	3.53 (0.65)	3.60 (0.59)	3.08 (0.61)	
Mean interests (female)	2.59 (0.82)	3.66 (0.73)	2.83 (0.87)	3.38 (0.84)	3.98 (0.57)	3.67 (0.58)	3.44 (0.63)	
Mean skills (total)	2.94 (0.80)	3.62 (0.59)	2.74 (0.78)	2.68 (0.71)	3.58 (0.58)	3.56 (0.56)	3.81 (0.53)	
Mean skills (male)	3.18 (0.78)	3.60 (0.60)	2.85 (0.75)	2.54 (0.67)	3.46 (0.57)	3.55 (0.56)	3.69 (0.52)	
Mean skills (female)	2.60 (0.69)	3.66 (0.58)	2.59 (0.79)	2.88 (0.71)	3.74 (0.55)	3.59 (0.55)	3.98 (0.50)	
Mean composite (interests and skills)	2.88 (0.77)	2.40 (0.42)	1.89 (0.51)	2.87 (0.74)	3.65 (0.59)	3.60 (0.54)	3.52 (0.53)	
Cronbach's α interests	.87	.75	.78	.83	.82	.79	.76	
Cronbach's α skills	.86	.72	.77	.77	.78	.79	.71	

Note. Subscale intercorrelations for the interest subscales (upper triangle) and skill subscales (lower triangle). On the diagonal between brackets the intercorrelations between the interest and skill subscales for the interest type in question. Behind means the *SD* between brackets. **Correlation is significant at the .01 level (2-tailed).

Table 4. Test–retest reliabilities and means for T1 and T2 (Study 3)

	Test–retest reliabilities		Mean interests			Means skills		
Scale	Interest	Skill	T1	T2	Cohen's *d*	T1	T2	Cohen's *d*
Realistic	.81**	.86**	2.80	2.80	0.00	2.86	2.89	−0.04
Investigative-humanities	.83**	.74**	3.50[b]	3.43	0.09	3.59	3.54	0.08
Investigative-science	.76**	.76**	2.88	2.93	−0.06	2.75	2.79	−0.05
Artistic	.86**	.87**	3.05	3.09	−0.05	2.74	2.76	−0.03
Social	.80**	.82**	3.85[b]	3.75	0.16	3.75[b]	3.62	0.25
Enterprising	.82**	.79**	3.68[b]	3.59	0.15	3.52[b]	3.45	0.13
Conventional	.75**	.79**	3.27[b]	3.13	0.23	3.80[b]	3.74	0.12
Average[a]	.81	.81						

Note. These correlations concern manifest correlations. [a]Using Fisher *r*-to-*z* transformation and back-transformation. [b]Significant difference between the first and second measurements ($p < .01$). **Correlation is significant at the .01 level (2-tailed).

Measures

The final version of the instrument investigated in this study, which will now be referred to as the Interest and Skill inventory on Educational Choices (ISEC), comprised 76 items at Time 1 as well as Time 2. All of the RIASEC-type scales (for interests as well as for skills) consisted of six items each, except for the investigative scale, which consisted of eight items (four items for each sub-factor).

Results and Conclusion Study 3

As can be seen in Table 4, test–retest reliabilities were between .74 and .86, indicating high test–retest reliability. The effect sizes of the differences between the scales at Time 1 and Time 2 were small (Cohen's $d < .2$) except for two cases (conventional interests and social skills).

Study 4: Construct Validity

To address RQ3 (establishing convergent and discriminant validity), we compared the ISEC with two well-established measures.

Method

Measures

ISEC

For this study we used the ISEC with 76 items, identical to the test–retest study (Study 3).

HZO

The first instrument we used to investigate the convergent and discriminant validity is an established Dutch instrument, the HZO (Platteel & Uterwijk, 2008). The HZO is the Dutch translation of the SDS and was chosen for this study because it is the most established Dutch interest scale that is based on Holland's theory. It is a self-report instrument designed to measure the six RIASEC types with regard to both interests and skills. The vocational preferences scales and the self-concept scales of the HZO were only taken into account for this study when comparing composite scores. The answering scale is binary (yes vs. no) and its scale reliabilities ranged from .89 to .93 (established with the Kuder-Richardson Formula 20).

PGI-Short

With four items per scale, the PGI-Short (Tracey, 2010) measures eight general interest scales: Social Facilitating, Managing, Business Detail, Data Processing, Mechanical, Nature/Outdoors, Artistic, and Helping. There are two additional prestigescales that were not used for the current study. Using the formulas provided by Tracey (2002), it is possible to transform the scores on these eight general interest scales into six RIASEC scale scores. Respondents are asked to respond twice to 32 unique items, with respect to both the degree of liking, ranging from 1 (= *strongly dislike very much*) to 7 (= *strongly like very much*) as well as the degree of competence ranging from 1 (= *unable to do*) to 7 (= *able to do very much*). The Cronbach's α of the eight scales for both interests and skills ranged between .71 and .90.

Participants

Participants were asked to fill out our ISEC, the HZO and the PGI-Short as part of a career counseling procedure. They received a small compensation of €15. The sample consisted of 102 young adults planning to (re-)enter higher education (42.2% female, M_{age} = 20.8, SD = 1.91), who sought services at the student career center of the university. This career center serves both students at the university and pupils from secondary education exploring their educational options. Although this sample may not be representative of the general population, it matches the subpopulation for which our instrument was developed.

Data Analysis

The convergent validity was examined by correlating the outcomes of the ISEC with outcomes of an equivalent subscale of the HZO or PGI-Short. Discriminant validity was computed by averaging the correlations with all dissimilar subscales of the HZO and PGI-Short.

Results

The correlations between our instrument and the HZO and PGI-Short interest scales are reported in Table 5. The table shows that correlations with convergent scales were positive and substantial in size (except for the conventional scale) and correlations with discrepant scales were small. The composite investigative-total subscale (r = .59, p < .001 and r = .48, p < .001) as well as the composite investigative-science subscale (r = .67, p < .001 and r = .57, p < .001) converged well with the corresponding HZO and PGI-Short scales, respectively. The convergent correlations between our investigative-humanities subscale and the HZO and PGI-Short investigative subscales were lower, however (r = .23, p < .05 and r = .15, *ns*, respectively). Furthermore, even though the correlation between our composite conventional subscale and the corresponding HZO scale was good (r = .55, p < .01) the correlation with the PGI-Short conventional scale was not significant (r = .15, *ns*).

Conclusion Study 4

Thus, the convergent and discriminant values were very adequate, except for the correlation between the conventional scales of our instrument and the PGI-Short.

General Discussion

The purpose of this paper was to develop and validate a short and publicly available interest measure for pupils in secondary education who orient toward undergraduate programs in higher education in the contemporary Dutch context. RQ1 addressed whether the instrument conformed to Holland's factor structure (i.e., RIASEC types) and whether this structure was invariant across gender. Preliminary results from Study 1 suggested that the expected factor structure was indeed found for all subscales (with partial gender invariance), except for the investigative subscale, which consisted of two sub-factors. These two sub-factors were labeled as investigative-humanities (tapping into a humanity aspect) and investigative-science (tapping into a natural science aspect). An additional face validity check supported the discriminant validity of these two investigative sub-factors. Overall, we concluded that our instrument had a clear factor structure (RQ1). However, the RIASEC scales did not conform to Holland's circumplex structure.

Circumplex analyses suggested that the estimated 6-factor model and 7-factor model of the interest and skill subscales did not fit the hexagonal structure of the RIASEC model very well. In the case of the 7-factor unconstrained and equal distance model, we did find the expected order conforming to the circumplex structure (i.e., first the realistic type followed by the investigative type, artistic type, social type, enterprising type, and conventional type, respectively). However, the models did not fit the suggested angles of the circumplex as specified in Figure 1. This is consistent with studies into other interest measures such as the Interest profiler (Armstrong et al., 2008) and the General Interest Structure Test (Nagy, Trautwein, & Lüdtke, 2010), which also have not reported a perfect fit

Table 5. Convergent validity for the interest, skill, and composite subscales (Study 4)

	HZO						PGI					
	Convergent validity (r)			Discriminant validity (r)			Convergent validity (r)			Discriminant validity (r)		
	Interest	Skill	Composite[a]	Interest[b]	Skill[b]	Composite[a]	Interest	Skill	Composite[a]	Interest[b]	Skill[b]	Composite[a]
Realistic	.73**	.70**	.82**	.02	.05	.01	.65**	.64**	.69**	.05	.06	.03
Investigative-total	.51**	.45**	.59**	.19	.21	.06	.48**	.42**	.48**	.26	.28	.14
Investigative-humanities	.22*	.03	.23*	.17	.23	.19	.24*	.09	.15	.20	.22	.21
Investigative-science	.61**	.59**	.67**	.14	.10	.09	.55**	.50**	.57**	.24	.22	.23
Artistic	.67**	.65**	.73**	.08	.10	.04	.64**	.75**	.73**	.11	.07	.11
Social	.69**	.60**	.74**	.10	.18	.10	.73**	.46**	.66**	.15	.14	.17
Enterprising	.66**	.72**	.73**	.10	.10	.09	.63**	.57**	.63**	.18	.19	.09
Conventional	.43**	.44**	.55**	.17	.12	.03	.23*	.14	.15	.23	.20	.10
Average[b]	.59	.56	.67	.12	.13	.08	.55	.48	.54	.17	.16	.14

Note. These correlations concern manifest correlations. [a]We correlated our interest and skill scales with all RIASEC scales of the HZO and PGI. [b]Using Fisher r-to-z transformation and back-transformation (Investigative-total scale excluded). *Correlation is significant at the .05 level (2-tailed). **Correlation is significant at the .01 level (2-tailed).

to these angles. Nonetheless, their models showed a better fit because theoretically opposite types were indeed (nearly) situated in the opposite direction on the circumplex, whereas in our case angles of less than 180° were found. A possible explanation for the difference in fit between the ISEC on the one hand and the Interest profiler and the General Interest Structure Test on the other hand, might be that these alternative questionnaires contain items representing occupational activities and/or job titles. It might therefore be the case that the original hexagonal structure as suggested by Holland most clearly represents the structure of occupational domains, as opposed to activities in daily life. Possibly, young people can relate more to the items of the ISEC (representing activities reflecting their daily lives) but these items may stand somewhat further away from the original RIASEC types as intended by Holland.

The finding of two investigative sub-factors is in line with the findings of Wille et al. (2015), who also differentiated between two investigative components. These authors found evidence for an "Investigative-Theory" factor, describing people who are eager to uncover "the how and the why" of processes and events and have a preference for social, economic, political, and philosophical science. Furthermore, Wille et al. (2015) found evidence for an "Investigative-Science" factor, describing people who prefer studying on problems from a fundamental perspective and are interested in work related to natural sciences, technology, engineering, and mathematics. The factors that were found by Wille et al. (2015) thus resemble our investigative-humanities and investigative-science sub-factors, respectively.

Internal consistency and test–retest reliabilities were satisfactory to good (RQ2). Furthermore, RQ3 focused on validity and found that our subscales correlated highly with the corresponding scales of the HZO and PGI-Short, supporting the convergent validity of six out of seven scales (for the conventional scale, convergent correlations were lower). Furthermore, for all scales the correlations with discrepant scales were low, supporting discriminant validity as well.

Although the correlations between our investigative-science and investigative-total subscales and the investigative scales of the PGI-Short and HZO were substantial, the correlations of our investigative-humanities subscale with the investigative scales of these other instruments were small. This is in accordance with the findings of Wille et al. (2015), who examined the convergent validity of their Career Insight Questionnaire for employed people (CIQ: Dingemanse, Van Amstel, De Fruyt, & Wille, 2007), comparing it with the PGI-Short. This suggested that the investigative items of the HZO and the PGI-short consist mostly of natural science items. The addition of more humanities-focused items to the ISEC therefore might be a useful addition that allows a broader coverage of student interests.

The convergence of our conventional scale with the PGI-Short was low. These findings were consistent with recent studies. For example, Etzel, Nagy, and Tracey, (2016) and Wille et al. (2015) found that of all equivalent RIASEC scales of the PGI, the conventional scale had the lowest convergent validity. A possible reason is that the conventional scale may be poorly defined in comparison to the other scales, as its definition might differ between historical and cultural contexts. More research is warranted on what the conventional scale actually measures and whether this is consistent with Holland's original intention.

We were also interested whether the measurement instrument would be comparable with its North American counterparts in terms of factor structure and psychometric properties. Unlike the North American instrument, the investigative scale in our instrument was characterized by an investigative-science scale (consistent with the investigative scales of most other interest measures) and an investigative-humanities scale. The investigative-science scale taps into the interests of pupils preferring studies like physics and applied science. The investigative-humanities scale taps into the interests of pupils who prefer studies that are research oriented in a more general and societal way (e.g., teacher history and teacher sociology).

All things considered, the ISEC matched the psychometric quality of the inventories listed in Table 1. The only scale that still merits some attention, analogous to other inventories, is the conventional scale. The development and validation of the ISEC suggested that the two investigative components of Wille et al. (2015) were also present in our younger target group. Thus, not only for employed adults, but also for younger prospective students, the RIASEC model might benefit from more fine-grained categorizations within the main RIASEC types. However, more future research is needed to substantiate this.

Limitations and Future Research

The present study has a number of limitations. We validated our instrument in the specific population of Dutch prospective students at the age of 16–25 years. Further research is necessary to see whether our results can be generalized across other vocational groups (e.g., employed, self-employed, and unemployed people) or other age groups. The validation sample was large and diverse (6,215 applicants for 68 different undergraduate programs), which increases the external validity of the results for this specific target group in higher education for which the instrument was developed. However, a limitation is that

these applicants already decided to continue their studies in tertiary education by choosing a specific major at an applied university. Hence, this sample was not identical to a sample of secondary school pupils with a wide variety of (other) vocational options (e.g., other majors or other kinds of schools or universities).

Second, in order to conduct analyses on the predictive validity of the inventory, further data need to be collected on the interest dimensions underlying the undergraduate programs. For this purpose, experts in vocational interest assessment could assign two- or three-letter codes to all available study programs (relying on prior empirical work describing the distribution of RIASEC interests across study programs). This exercise is also needed in order to create a feedback tool that matches students' interest profiles to a list of congruent undergraduate programs (see, e.g., Fonteyne, Wille, Duyck, & De Fruyt, 2017). Subsequently, fit indices (such as the C-index Brown & Gore, 1994 or the Zener & Schnuelle index 1976) between the student and his/her undergraduate program could be computed. It could then be investigated whether outcome measures such as study satisfaction or turnover intention can be predicted by congruence/fit. Response surface methodology could also help to shed light on the relation between fit and these outcome measures (e.g., Lambert, Edwards, & Cable, 2003).

Practical Implications

Dutch students have to specialize immediately upon entering higher education. The ISEC can help individual pupils in secondary education obtain a sense of direction in the labyrinth of undergraduate programs. By completing the ISEC, pupils get feedback on what their main interest types are. It is also possible that counselors in secondary education use this instrument for their pupils as a starting point in their counselling.

The ISEC can also be used by counsellors to match the pupil's outcomes (interest types) to certain domains of education or more specific undergraduate programs. Also, the prospective students themselves can base their educational decision on the degree of congruence between their interest scores and a particular program. Alternatively, teachers of these programs can base their recruiting or selection strategies on this congruence.

Conclusion

The ISEC is a promising measure assessing interests and self-perceived skills of pupils in secondary education encouraging their exploration of undergraduate programs. In the present context, the instrument demonstrated good psychometric properties in tapping into the interests and skills of Dutch pupils on the verge of an educational decision. Using this measure can potentially result in a better fit of prospective students with their undergraduate programs regarding their interests and skills, and ultimately result in less dropout as a consequence of erroneous educational choices.

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at http://doi.org/10.1027/1015-5759/a000546

ESM 1. Extra information can be found on exploratory analyses (Appendices A and B), circumplex models (Appendix C), invariance analyses (Appendix D), and the items in Dutch (Appendix E).

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