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Validation Study of a General Subject-matter Interest Measure: The Individual Interest Questionnaire (IIQ)

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Abstract

Importance: Interest is considered a significant educational construct. A validated instrument that can reliably be used to measure interest across different subject domains is however not available.
Objective: To report the findings of two studies that were conducted to test the validity and reliability of a newly designed Individual Interest Questionnaire (IIQ).
Design: Study 1 was a construct validation study involving three independent high school samples from different disciplines. In Study 2 the predictive validity of the IIQ was tested by examining how well the IIQ predicts cognitive engagement and on-task behaviors and attitudes of students.
Participants: A sample of 230 chemistry, geography, and history high school students (Study 1) and 82 biology high school students (Study 2).
Setting: High schools in Singapore.
Main outcome measures: Confirmatory factor analysis, Hancock's coefficient *H,* test of multi-group invariance, cognitive engagement and on-task behaviors and attitudes (i.e., curiosity, enjoyment, self-efficacy, attention, and boredom).
Results: Confirmatory factor analysis for the three samples suggest adequate fit of the data with the hypothesized model: History: χ^2/df = 1.47; p = .13, RMSEA = .08, CFI = .96; Chemistry: χ^2/df = 1.41; p = .17, RMSEA = .07, CFI = .98; and Geography: χ^2/df = 1.51; p = .11, RMSEA = .09, CFI = .94. Reliability analysis revealed high levels of reliability of the IIQ: coefficient H History: .81; coefficient H Chemistry: 85; and coefficient H Geography: .85. The test for multi-group invariance was ns, suggesting that the factor structure of the IIQ was invariant across the three subjects. The data fitted the predictive path model well: χ^2/df = 1.60; p = .11, CFI = .98, RMSEA = .09 and the standardized regression weights of individual interest for the outcome measures ranged from: .69 ($p < .001$) cognitive engagement to −.24 (p = .03) boredom.
Conclusion and relevance: The results suggest that the IIQ is a reliable and valid instrument to measure individual interest across different disciplines and demonstrated adequate predictive validity for cognitive engagement and on-task behaviors and attitudes. The IIQ fills the gap in the literature for a generic instrument to measure individual interest.

Keywords: Individual Interest Questionnaire; Validation; Confirmatory Factor Analysis; Individual Interest; Predictive Validity

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1. Introduction

Most people would tend to agree that interest drives learning; students who are interested in say biochemistry, are more engaged during class, spent more hours studying it, and have typically more knowledge about the topic than students with less interest in the topic.[1–5] Indeed, a meta-analysis by Schiefele and Krapp,[6] involving 121 studies showed that the average correlation between interest and academic achievement was .31. Interest has also been described as a powerful predictor of study success in college and can predict future study choices.[3,7] For instance, Harackiewicz et al.[8] conducted a study with high-school students who just entered an introductory psychology course at university. The results of the study suggest that students' interest, together with prior performance, predicted their study choices (e.g., choosing for a major in psychology) and study success in general.

Following from the above, interest can be considered a construct of considerable educational significance. Despite the general agreement among educators and researchers about its importance,[9,10] a reliable and valid instrument that is capable of measuring interest across a variety of educational settings and contexts is still missing.[11] To address this shortcoming, the objective of the present study was to devise and test a new interest questionnaire that can generically be used in diverse educational disciplines. Before we further elaborate on the conceptualization and operationalization of the new instrument, we will first provide a brief summary of the interest literature and highlight two potential shortcomings of the existing instruments.

Interest is not a unitary concept and the literature distinguishes between individual interest[9,12] and situational interest.[13,14] Individual interest refers to a more or less stable type of interest, such as a deep-seated interest in physiology, in science, in music, sports, or travel.[15] This interest develops over time and is considered a predisposition to engage and reengage with particular content over time.[16] Situational interest on the other hand is considered a fleeting type of interest, which is aroused by environmental conditions and stimuli, such as puzzles, authentic problems, surprising or unexpected phenomena, and is thus more easily manipulated and under the control of teachers.[17–20] The present study is about the former, individual interest, being a general, deep-seated interest of a person, which develops slowly over time and is not easily manipulated.

According to a number of recent publications, interest research is challenged by a lack of a unifying conceptualization of what interest constitutes and associated to this, how interest is measured. For instance in a recent review, Renninger and Hidi[11] commented that advances in interest research are significantly obstructed by different conceptualizations and operationalization of interest. Indeed, this problem is witnessed by the large variety of questionnaires used across different studies. In fact, it appears that there is not one established instrument that was consistently used across studies and by different researches. This we believe is the first major limitation of the existing instruments.

Taking a closer look at the studies, the reason for using different instruments seems to be less an issue of conceptualization, but rather practicality dictated by the contextual conditions of these studies. Although most studies carry generalizable titles about interest and how it affects student learning, the operationalization of the studies is typically less generalizable and boils down to individually devised specific questionnaires that fit into a very narrowly defined subject domain or educational context. This makes it difficult to use these instruments for other studies and by different researchers.

For instance, Lawless and Kulikowich,[1] conducted a study to investigate the impact of domain knowledge and individual interest on learning. The study was conducted within the educational context of applied statistics and psychology. As a consequence, the items of their individual interest measure were rather context-specific, which makes it difficult to apply the measure to other disciplines (e.g., "*I am interested in designing experiments with interventions*"; "*I am interested in the testing of research hypotheses*"; and "*I am interested in the study of the brain and its functions*"; "*I am interested in learning about language acquisition*"). A similar example is the study by Albin and Benton[21] in which they examined individual differences in interest and narrative writing about baseball and soccer. For this study two Individual Interest Questionnaires were used to measure students' interest in soccer and baseball. Again, the items are rather specific and restricted to the sports context (e.g., "*Would you ever be interested in playing baseball?*"; "*Does anyone in your family play softball/baseball/slowpitch?*"; and "*What is your degree of interest in the game of baseball?*"). Although the measures were validated and showed adequate levels of reliability, these Individual Interest Questionnaires are of little use to researchers who would like to use them for other disciplines or subject domains, for instance physiology, or cardiology. And, although the above questionnaires were adequately validated, the majority of them were not subjected to an adequate construct validation procedure, which may be an additional contributing factor why a general measure of individual interest did not emerge.

A second limitation of the existing instruments is quite the opposite than what we have discussed so far. There are many researchers who operationalized individual interest simply by using only one single item.[22] For instance, in a study by Dotterer et al.,[23] about the development of academic interest one item was used to measure individual interest: "*How interested are you in…?*" In another study by Kalender and Berberoglu,[24] in which individual interest was reported as a predictor for science achievement, also only one single item was used: "*How interested are you in science?*" In yet another study by Reeve[25] about the "interest-enjoyment distinction of intrinsic motivation, also one item was used to measure individual interest: "*How interesting are the anagrams?*"

Admittedly, there is some consensus in the literature that if the construct being measured is sufficiently narrow and unambiguous to the respondent, a single item measure can be used. Considering however that the conceptualization of individual interest is much broader, we argue that more items are needed to capture the full essence of the construct. Take for instance the following definition of individual interest that frequently emerged in the literature: "*individual interest develops over time and is a relatively enduring predisposition to attend to objects, events, ideas, etc., and to reengage with particular content. Moreover, this process is considered to be associated with positive feelings, increased value and knowledge*".[1,10,12,14,16,26–31] To do justice to this broader definition of individual interest, the instrument should measure at least the following three key components of the definition: (a) willingness to reengage with particular content, (b) positive feelings, and (c) increased value for the topic. To capture these key components we devised seven items that can be administered in different educational contexts, e.g. for different subject domains and with different student populations, ranging from primary school to university. Before the actual validation study was carried out we conducted an item analysis by asking a selected group of students to give us feedback on the clarity of the items. The complete questionnaire with all items can be found in the Appendix.

To test the validity and reliability of the newly devised individual interest questionnaire, or IIQ, two studies were conducted. The purpose of the first study was to test the construct validity of the IIQ. We selected three samples from different high school student populations spanning across different disciplines, such as Life sciences, Geography, and History. We selected participants from high school because at this stage dispositional preferences for certain subjects seem to emerge and are potentially significant predictors of study selection once they enter university.[32,33] Confirmatory factor analyses were carried out to test the *construct validity* of the IIQ. In addition, reliability tests for latent variable systems were carried out to assess the *reliability* of the instrument. The IIQ was administered for three independent samples. Tests of multi-group invariance using structural equation modeling were carried out to establish the *external validity* of the measure.

The objective of the second study was to test the *predictive validity* of the IIQ. To that end, it was investigated to which extent the IIQ can predict students' cognitive engagement and "on-task behaviors and attitudes" for a biology course. On-task behaviors and attitudes are behaviors and attitudes that emerge when working on an instructional task, for instance a lab assignment or a medical case. We selected five on-task variables—curiosity, enjoyment, self-efficacy, attention, boredom—from which it is known that they have a profound influence on students' task involvement and learning outcomes. For instance, Rotgans and Schmidt,[34] demonstrated that cognitive engagement in a problem-based learning environment was a significant predictor of how much students learned during a task. Curiosity has been linked, not only to exploratory behavior in school,[35] but also to diagnostic competence and patient care.[36,37] Enjoyment has been associated with superior self-regulated learning behaviors,[38] task valued and interest[39], and predicted learning outcomes.[40] Attention is a significant cognitive factor that facilitates task engagement and performance.[41] Self-efficacy is considered an important person characteristic that leads to mastery performance.[32,42,43]

Considering that these on-task variables seem to have a positive effect on learning behavior and outcomes, it would be beneficial if one could adequately predict these variables with another more stable ("trait-like") measure that does not require frequent administration. With the present study we examined whether the IIQ is a good candidate to do this job. A biology course was chosen in which students learned about the human digestive system. We expected to find positive associations, except for boredom, since interest can be considered the opposite of boredom.

2. Study 1: construct validation of the IIQ

2.1. Method

2.1.1. Participants

The construct validation study was conducted with three independent samples from three different high schools. From each school we selected one study subject for which in turn two classes were randomly selected. See Table 1 for an overview of the demographics of the three samples.

Table 1
Sample size, age, and gender from three different validation samples.

Sample	*N*	Gender	Age (*SD*)
History	72	50% female	14 (.03)
Chemistry	93	46% female	13 (.00)
Geography	65	48% female	14 (.00)

2.1.2. Materials and procedure

2.1.2.1. Individual Interest Questionnaire. The IIQ consists of seven items that all load on one single factor and measures students' predisposition and willingness to engage with a school subject, their positive affect towards the subject, and their willingness to re-engage with the subject over time. The items are as follows[2]: (1) "*I am very interested in Chemistry*"; (2) "*I always look forward to my Chemistry lessons, because I enjoy them a lot*"; (3) "*I am interested in Chemistry since I was young*"; (4) "*Later in my life I want to pursue a career in Chemistry or a Chemistry-related discipline*"; (5) "*Outside of school I read a lot about Chemistry*"; (6) "*I watch a lot of Chemistry-related TV programs (e.g., discovery channel)*"; and (7) "*When I am reading something about Chemistry, or watch something about Chemistry on TV, I am fully focused and forget everything around me.*" All items were scored on a 5-point Likert scale: 1 (*not true at all*), 2 (*not true for me*), 3 (*neutral*), 4 (*true for me*), and 5 (*very true for me*).

At the beginning of a History, Chemistry, or Geography class respectively, the regular teacher administered the IIQ to his/her own class. The teacher read out the instructions and emphasized that when responding to the questionnaire the students should think about the school subject in general. The administration took less than five minutes.

2.1.3. Data analysis

Confirmatory Factor Analyses (CFAs) were conducted to test the construct validity of the IIQ. First, individual CFAs were generated for each of the three samples separately. Parameter estimates were generated using maximum likelihood and tests of goodness of fit. Chi-square accompanied by degrees of freedom, sample size, *p*-value and the root mean square error of approximation (RMSEA) were used as indices of absolute fit between the models and the data. The Chi-square is a statistical measure to test the closeness of fit between the observed and predicted covariance matrix. A small Chi-square value, relative to the degrees of freedom, indicates a good fit.[44] A Chi-square/df ratio of less than 3 is considered to be indicative of a good fit. RMSEA is sensitive to model specification and is minimally influenced by sample size and not overly affected by estimation method.[45] The lower the RMSEA value, the better the fit. A commonly reported cut-off value is .06.[46] In addition to these absolute fit indices, the comparative fit index (CFI) was calculated. The CFI value ranges from zero to one and a value greater than .95 is conventionally considered a good model fit.[47]

Hancock's coefficient *H* was calculated as a measure of the construct reliability for latent variable systems which represents an adequate alternative to the conventional Cronbach's alpha. According to Hancock and Mueller,[48] the usefulness of Cronbach's alpha and related reliability measures is limited to assessing composite scales formed from a construct's indicators, rather than assessing the reliability of the latent construct itself as reflected by its indicators (see also 49,50). The coefficient *H* is the squared correlation between a latent construct and the optimum linear composite formed by its indicators. Unlike other reliability measures the coefficient *H* is never less than the best indicator's reliability. In other words, a factor inferred from multiple indicator variables should never be less reliable than the best single indicator alone. Hancock recommended a cut-off value for the coefficient *H* of .70.

As a last step, a test of multi-group invariance was conducted to examine if the factorial structure of the IIQ was not different between the three subject domains.[44] To that end, the models representing the three subjects were tested with both unconstrained and

[2]*Note*: These are the items to measure individual interest for the subject *Chemistry*. For the other subjects, "Chemistry" was replaced by "Geography" and "History".

Table 2
Results confirmatory factor analysis and coefficient H for history, chemistry, and geography individual interest measure.

Sample	Model Fit Indices	Coefficient *H*
History (*N*=72)	χ^2/df=1. 47; *p*=.13 RMSEA=.08 CFI=.96	.81
Chemistry (*N*=93)	χ^2/df=1.41; *p*=.17 RMSEA=.07 CFI=.98	.85
Geography (*N*=65)	χ^2/df=1.51; *p*=.11 RMSEA=.09 CFI=.94	.85

Table 3
Results of the test for multi-group invariance between the subjects history, chemistry, and geography.

Model	χ^2	df	$\Delta\chi^2$	Δdf	Statistical Significance
Unconstrained model	128.00	42	–	–	
Constrained model	148.69	54	20.69	12	n.s.

constrained factor loadings. Significant differences in Chi-square value between the constrained and unconstrained models in relation to the difference in degrees of freedom reveals the extent to which the IIQ is capable of validly measuring across different subject domains.

2.2. Results and discussion

The results of the CFAs for the three subjects History, Chemistry, and Geography revealed that the data fitted the hypothesized models well. All factor loadings of the individual items were statistically significant and thus adequately contribute to explaining the latent construct. The coefficient *H* values for the three models were adequate and all were well above the .70 cut off. See Table 2 for an overview of the results.

To further test the external validity of the IIQ, we conducted a cross-validation by means of a test of multi-group invariance between the three subject domains. The $\Delta\chi^2$ (df=12) value was 20.69 (*ns.*), which suggests that the underlying factor structure of the IIQ was non-significantly different between the three subject domains. See Table 3 for an overview. This outcome suggests that the IIQ can reliably and validly be used in a variety of subject domains.

Overall, the results of Study 1 provide empirical support for the validity and reliability of the IIQ. The objective of Study 2 was to further explore how well the IIQ can predict cognitive engagement and related on-task behaviors/attitudes.

3. Study 2: predictive validity of the IIQ

3.1. Method

3.1.1. Participants

The second study was conducted with 82 high school students (45% female) enrolled in a biology course on the human digestive system. The participants' average age was 13 years (SD=.64).

3.1.2. Materials and procedure

3.1.2.1. Individual Interest Questionnaire. The IIQ was used in the analysis as a measure of students' individual interest in science. The coefficient *H* was .87.

3.1.2.2. Cognitive engagement. In order to measure students' cognitive engagement during the biology course, the *Situational Cognitive Engagement* (SCE) measure was administered. The SCE is a validated instrument developed by Rotgans and Schmidt.[34] The instrument consists of five items (example item: "*I was engaged with the topic at hand*"), and is scored on 5-point Likert scale. The coefficient *H* for this measure was .88.

3.1.2.3. On-task variables. To determine a variety of on-task behaviors and attitudes, we administered six single-item measures to determine students' curiosity ("*I want to know more about this topic*"), enjoyment ("*I enjoy working on this topic*"), self-efficacy ("*I expect to master this topic well*"), attention ("*I am fully focused on this topic; I am not distracted by other things*"), and boredom ("*I feel bored*"). All items were scored on a 5-point Liter scale.

Prior to the biology course, participants' individual interest for science was measured by administering the IIQ. The biology course consisted of two 1-h online sessions in which students were presented texts and videos that explained how the human digestive system works. During the first session, the on-task variables were administered. The administration was done online towards the second half of the session. A pop-up window appeared and participants responded to the individual items. Toward the end of the second session, the cognitive engagement measure was administered to determine how engaged the participants were during the course.

Table 4
Zero-order correlations and descriptive statistics for the biology course on the human digestive system.

Variables	1	2	3	4	5	6	7
1.Individual interest	–						
2.Cognitive engagement	.69***	–					
3.Curiosity	.64***	.59***	–				
4.Enjoyment	.63***	.54***	.71***	–			
5.Self-efficacy	.44***	.47***	.43***	.48***	–		
6.Attention	.51***	.57***	.41***	.39***	.47***	–	
7.Boredom	−.24*	−.27*	−.55***	−.42***	−.13	−.08	–
Mean	3.27	3.50	3.65	3.56	3.70	3.18	2.85
SD	.74	.63	.79	.77	.84	.80	1.09

*$p < .05$.
***$p < .001$.

3.1.3. Data analysis

To examine how the IIQ predicts cognitive engagement and the on-task variables, a path analysis was carried out in which individual interest in science was regressed on the remaining six measures: cognitive engagement, curiosity, enjoyment, self-efficacy, attention, boredom, and knowledge. The path analysis was carried out using structural equation modeling.[44]

3.2. Results and discussion

As a first step in the analysis descriptive statistics and zero-order correlations were generated. See Table 4 for an overview.

Next, the path model was tested using a structural equation modeling approach. The data fitted the model reasonably well: χ^2/df = 1.60; $p = .11$, CFI = .98, RMSEA = .09. All factor loadings were statistically significant, which suggests that the IIQ is an adequate predictor of all the variables included in the model. See Fig. 1 for an overview.

Although the IIQ was a significant predictor of all measured variables, the results of the path analysis revealed that the IIQ was a particularly strong predictor of cognitive engagement (standardized $\beta = .69$, $p < .001$), explaining 48% of the variance. This outcome suggests that the individual interest students have in a subject, such as biology, is a relatively strong predictor of how willing they are to engage with the subject during a class activity.

Besides cognitive engagement, the IIQ was also a relatively suitable predictor for the other five on-task measures. It explained 40% of the variance in curiosity and enjoyment (standardized $\beta = .63$, $p < .001$ for both

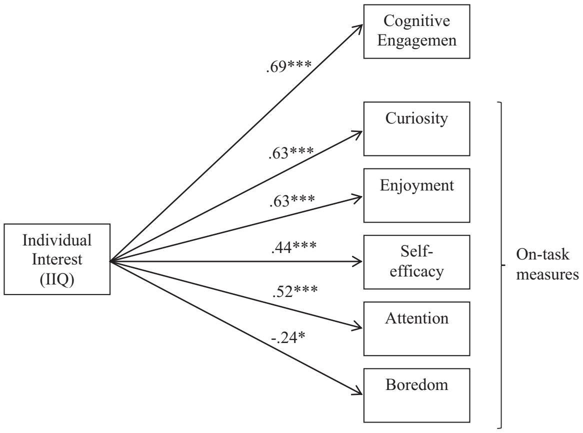

Fig. 1. Path model displaying standardized regression weights between Individual Interest (IIQ) cognitive engagement and on-task measures for the biology course on the human digestive system. *Note*: *$p < .05$. ***$p < .001$.

variables), but also how much attention students exerted during the course (standardized $\beta = .52$, $p < .001$). The IIQ was also a relatively strong predictor of self-efficacy (standardized $\beta = .44$, $p < .001$), a more trait-like disposition of one's perceived mastery capabilities, of which 19% of the variance could be explained.

A negative factor loading was observed between individual interest and boredom (standardized $\beta = -.24$, $p = .03$), explaining 6% of the variance. This negative relationship was expected, suggesting that interest and boredom are inversely related.

4. General Discussion

The objective of this paper is to report the findings of two studies that were conducted to test the validity and reliability of a newly developed Individual Interest Questionnaire (IIQ). The instrument is different from existing instruments in the sense that it was (a) devised in a top-down manner based on the contemporary definition of the construct individual interest and (b) it can generically be administered for diverse subject domains across different educational contexts. The first study involved three confirmatory factor analyses and a test of invariant factorial structures. The results suggest that the IIQ is a valid instrument to measure individual interest reliably across the three subject domains. Having established the construct validity and external validity of the measure, the objective of the second study was to explore how well the IIQ can predict a range of task-relevant measures including cognitive engagement, curiosity, enjoyment, self-efficacy, attention, and boredom. The results revealed that the IIQ was a significant predictor for all these on-task behaviors and attitudes. Besides the hypothesized positive associations, a negative correlation was observed between interest and boredom, which suggests that the instrument was sufficiently sensitive to discriminate between positive and negative on-task attitudes. This outcome substantially adds credibility to the findings of the predictive validity analysis. Another interesting finding is that the IIQ was particularly strong in predicting participants' cognitive engagement with the task-at-hand (standardized $\beta = .69$). This is a first, since most existing studies that used trait-like variables to predict cognitive engagement typically failed to produce strong correlations. For instance in a study by Dupeyrat and Mariné,[51] measures such as implicit theories of intelligence and goal orientation did not predict cognitive engagement very well ($r < .30$). Similarly, Meece et al.,[52] conducted a study in which intrinsic motivation was used to predict cognitive engagement, among other variables. As with the previous study, they found a weak correlation (standardized $\beta = .12$). Compared to these studies, the IIQ performed much better as a dispositional measure to predict contextual variables, effectively doubling the amount of variance that could be explained in students' cognitive engagement. Considering this outcome, it appears appropriate to consider using individual interest in future studies as a predictor of on-task measures and student performance. In particular, it would be interesting to conduct a follow-up study with health sciences students to examine if there are individual and group differences in interest with regard to various medical topics and whether the IIQ predicts study success for these topics.

In conclusion, the findings of the two studies reported in this paper provide empirical support for the validity (construct validity, external validity, and predictive validity) of the newly devised IIQ. In addition, we provided reliability evidence and demonstrated that the instrument can be used across various disciplines. As such, we believe to have demonstrated that the IIQ has sound psychometric properties to be used as a measure of individual interest.

Author contributions

Jerome Rotgans had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study conception and design: Jerome Rotgans.

Preparation of materials: Jerome Rotgans.

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Conflicts of interest

None.

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Appendix. The Individual Interest Questionnaire (IIQ)

Please indicate below, on a scale from 1 (*not true at all for me*) to 5 (*very true for me*), how true are the statements for you **in general**.

1	I am very interested in biochemistry	1 *Not true at all*	2 *Not true for me*	3 *Neutral*	4 *True for me*	5 *Very true for me*
2	Outside of school I read a lot about biochemistry	1 *Not true at all*	2 *Not true for me*	3 *Neutral*	4 *True for me*	5 *Very true for me*
3	I always look forward to my biochemistry	1 *Not true*	2 *Not true*	3 *Neutral*	4	5 *Very true*

	lessons, because I enjoy them a lot	*at all*	*for me*		*True for me*	*for me*
4	I am interested in biochemistry since I was young	1 *Not true at all*	2 *Not true for me*	3 *Neutral*	4 *True for me*	5 *Very true for me*
5	I watch a lot of biochemistry-related TV programs (e.g., Discovery Channel)	1 *Not true at all*	2 *Not true for me*	3 *Neutral*	4 *True for me*	5 *Very true for me*
6	Later in my life I want to pursue a career in biochemistry or a biochemistry-related discipline	1 *Not true at all*	2 *Not true for me*	3 *Neutral*	4 *True for me*	5 *Very true for me*
7	When I am reading something about biochemistry, or watch something about biochemistry on TV, I am fully focused and forget everything around me	1 *Not true at all*	2 *Not true for me*	3 *Neutral*	4 *True for me*	5 *Very true for me*

NOTE: The example items above measure students' individual interest in "biochemistry." If interest for another subject or discipline is to be measured, say "physiology," the items need to be changed by replacing "biochemistry" with "physiology".

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