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Validity Evidence for the Perceptions of Secondary School Students of 'What Research is' Scale and Measurement Invariance

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Abstract: Research is a concrete action in academia which has uplifted societies' prosperity. Although researchers have given particular attention to student perceptions about what research is in a higher education context, little attention has been given to secondary school students' perceptions about this issue. To fill this gap, Yeoman et al. (2016) qualitatively developed an instrument measuring secondary school students' perceptions of what research is. The present study quantitatively validates this scale using the dataset originally used to qualitatively validate it. The factor structure of the 'what research is' scale and measurement invariance across gender, school type, and key stage was examined. The sample is composed of 2634 secondary school students in seven schools located in East Anglia, UK. The data from this original sample showed a relatively acceptable fit to the four-factor structure after omitting some items. The result also highlighted that whilst there was evidence on configural and metric level invariance (i.e. the factor structures and the factor loadings of the scale are equivalent across gender, school type, and key stage), scalar level invariance was not met (i.e. the item intercepts of the scale are not equivalent across gender, school type, and key stage). Recommendations for future studies and future directions for research are discussed.

1. INTRODUCTION

Over the last few decades, with the expeditious advancement and development of technology, societies and organizations have become dependent on research to keep up with these changes (Bazley, 2019; Nishimura et al., 2019). Ensuring the education system's capability to integrate research-related activities to keep abreast of the advancements taking place in the world has been indispensable (Mosher, 2018; Saleem et al., 2020). Encouraging young people to give importance to research from an early age is of a growing importance in order to broaden the participation of research-related activities in the future (Moore & Hooley, 2012). Accordingly, having students participate in research related activities in their early school years is crucial to whether they choose a research related career in the future (Archer et al., 2013; Archer et al., 2020). Therefore, it would seem logical to acknowledge students' perceptions of what research

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is and how students perceive research as a potential future career choice during early school years.

Although societies have become progressively more reliant on science and technology, previous studies found that very few students are choosing subjects related to STEM (science, technology, engineering, and mathematics) or considering these areas for a future career (Archer et al., 2020; Donghong & Shunke, 2008; Moore & Hooley, 2012; Mejía-Rodríguez, 2020). There are many reasons why students do not consider science and technology as a future career choice. These include students' attitudes to science at school and parental attitudes (DeWitt & Archer, 2015; Toma & Greca, 2018). There are few studies which examine whether young students have sufficient knowledge about what research is and why people do research (Yeoman et al., 2016; Yeoman et al., 2017).

Furthermore, there is little clarity on whether there is a relationship between students' perceptions about what the research is and the education level they are at (Griffioen, 2019). For example, in studies of undergraduate students, Pearson et al., (2017) stated that students considered research experiences to be beneficial but also found them to be time-consuming. Studies such as this help us understand student perceptions of the research experience and can provide useful information for faculty that are interested in engaging students in the research process. Santos et al., (2017) highlighted that most students did not intend to pursue an academic career. For this reason, it has become more important to learn how the concept of research is shaped by young students and their attitudes towards research (Griffioen, 2019; Griffioen, 2020). This is important in determining whether students become good researchers in the future (Griffioen, 2019; Griffioen, 2020). Therefore, students' perceptions of, and attitudes towards, research at this early stage (secondary school), influence their future career choices (Yeoman et al., 2017).

The present study aims to validate a measurement instrument developed by Yeoman et al. (2016) on research attitudes and research integration that can be used with secondary school students. In this study, the researchers attempt to prove the psychometric properties of students' perception of the 'what research is' scale quantitatively. This questionnaire has been extensively validated using qualitative methods (through piloting and through building each item out of existing studies on public perceptions of research), however, the factor structure has not been validated quantitatively. This research aims to evaluate the psychometric properties of this scale and test its validity and reliability.

In the following section, we present a brief conceptual summary of the 'what research is' scale and its conceptualization. Later, we summarise previous studies that examine students' perceptions of what research is in different educational settings. Next, we illustrate our sample, variables, analytical strategy and present our findings. Lastly, we discuss our results and present implications for both policy-making and future research.

1.1. Conceptualizations of the 'What research is' scale

In this section we briefly present concepts used by Yeoman et al. (2016) to develop the 'what research is' scale –who does research?, the value of research, the process of research and myself and research.

1.1.1. Who does research?

Research is a collection of activities that includes systematically collecting, analyzing, interpreting and evaluating data, and presenting results in a consistent manner, in order to contribute to science and humanity. Scientific research is defined by Santos et al. (2017, p.45) as "a process that occurs in all areas of knowledge and therefore society depends on it". As a general definition, people who carry out these processes are also called researchers (Çaparlar & Dönmez, 2016). According to the OECD (2015, p.162) "researchers are professionals engaged in the conception or creation of new knowledge. They conduct research and improve or develop concepts, theories, models, techniques instrumentation, software or operational methods".

1.1.2. The value of research

The value of research is defined by Georghiou (2015, p.4) as "consumption through its instrinct value as a cultural good and symbol of human achievement". There are several ways to ensure that research is valuable, effective, and of high quality (Salter & Martin, 2001). This includes increasing the stock of useful knowledge, training skilled people, creating new scientific instrumentation and methodologies, and collaborating in research projects and networks with users (Georghiou, 2015).

Specifically, in the United Kingdom, the Research Excellence Framework (REF) has given substantial attention to the assessment of the research performance of universities and is being used to make funding allocation decisions (Georghiou, 2015). Another evaluation criterion is, at the institutional level, measuring the effect of universities on the UK economy as if it were an industrial establishment (Kelly et al., 2014). As a result, it is expected that the value of research will be reflected in society economically, socially, and culturally either in the short or long term.

1.1.3. The process of research

Generally, research begins with choosing the research topic. Then, based on this, the researcher proposes the research aim, objectives, and research questions. The researcher will then comprehesively investigate what has been done so far in this area, decide on data collection methods, collect the data, and carry out data analysis. Conclusions are then drawn and lastly research papers are prepared (Brew, 2001).

1.1.4. Myself and research

Self-efficacy is defined as someones' belief in their potential to complete a time-bound task (Bandura, 2006). 'Myself and research' refers to someones' capability or self-efficacy to conduct research by him/herself (Griffioen & De Jong, 2015). In the literature, some studies have been administered which dealt with students' capability(self-efficacy) across different subjects such as mathematics and science (Britner & Pajares, 2006; Butz & Usher, 2015) but these were limited to within a higher education context (Webb-Williams, 2017).

1.3. Studies That Examine Students Perceptions of What Research is

Considerable research has been conducted investigating the perceptions of research of undergraduate students (Ommering et al., 2020), postgraduate students (Meyer et al., 2005, 2007; Pitcher, 2011), postdoctoral researchers (Pitcher & Åkerlind, 2009), experienced researchers (Åkerlind, 2008; Brew, 2001), and postgraduate supervisors (Bills, 2004; Kiley & Mullins, 2005).

Recently, Griffioen (2019) conducted a study to examine the relationship between students' intention to use research in their future professional practice and their perceptions of and attitudes toward research. A sample of 2192 undergraduate students in an applied sciences university in the Netherlands was used. It was found that there was a high association with students' intention to use research in their future professional practice and their perceptions of and attitudes toward research. Furthermore, another study by Griffioen (2020) examined differences in students' experiences of research involvement by study year (grade) and disciplines (majors) using the same sample as above. The study's findings revealed that research involvement showed a different pattern for students across study years and disciplines. Therefore, these studies showed how the relationship between students' perceptions of what research is and their intention to benefit from research in their professional lives might change depending on their year of study and their discipline. It is therefore important that year of study and discipline are not overlooked.

There are very few studies that have explored the perceptions of research of secondary school pupils and the value they place on research for their future careers (Yeoman et al., 2016). Grever et al. (2008) conducted a study in the Netherlands and England with 400 young people concerning students' views on history at school and identity. The study showed that there were substantial differences between young peoples' opinions about identity and history. Another study was carried out by Schmidt et al. (2019) with 306 middle school students about their perceptions concerning the field of science and its applicability to daily life situations. They pointed out the importance and critical role of teachers in students' perception of sciences' utility for their daily activities. The more teachers make the connection with daily life, the more students consider science as useful and practical. Thus, these studies provide information about students' comprehension of school subjects and how the perception varies between young people.

With regard to measurement instrument, Visser-Wijnveen et al. (2016) developed the Student Perception of Research Integration Questionnaire (SPRIQ) to capture how students conceive research integration with 221 undergraduate students at a research-intensive university in the Netherlands. Another questionnaire developed by Griffioen (2019) the Research Attitudes in Vocational Education Questionnaire (RAVE-Q) to assess undergraduate students' attitude towards research, which consists of perceptions of research in profession, cognitive attitude towards research, positive affective attitude towards research, negative affective attitude towards research, self-efficacy towards research, the importance of research, and intuition to show research related behaviour dimensions. Moreover, Griffioen (2020) designed a questionnaire to compare lecturers' and students' higher education research integration experience based on the RAVE-Q (Griffioen, 2019) and Research Experience scale (Verbugh & Elen, 2011).

So far, to the best of our knowledge, a measurement instrument has not been developed to capture secondary school students' perceptions of what research is. To fill in the secondary school context gap, the University of East Anglia's research team conducted a project as a potential contributor to this under-researched area by exploring how pupils currently conceive research and science (Yeoman et al., 2016). As part of this project, they designed a questionnaire to gauge secondary school pupil's perception of what research is (Yeoman et al., 2016). However, this questionnaire has not been validated using quantitative methods.

1.4. The Present Study

As mentioned previously, the main purpose of the current study is to investigate the psychometric characteristics of Secondary School Students' Perception of the 'what research is' Scale, quantitatively. To this end, the scale (Yeoman et al., 2016) that was developed with secondary school students was validated using the sample of secondary school students originally used to qualitatively validate the scale. In this paper we attempt to verify the four dimensions of the 'what research is' scale – who does research, the value of research, the process of research, and myself and research – quantitatively in secondary school students (Hypothesis 1).

Research Question 1: Can the structure of this scale be confirmed quantitatively?

Some researchers investigate the relationship between students' gender, school type, and grade and their perceptions of what research is. To do this, this questionnaire should show measurement invariance across groups (Gender (male or female), School Type (state or independent), Key Stage (KS3, KS4, and KS5)). Otherwise, making comparisons between these sub-groups is problematic and researchers should be cautious about making such comparisons.

The secondary purpose of this study is to test whether the factor structure of secondary students' perception of what research is has measurement invariance across gender groups (Hypothesis 2a), across school type (Hypothesis 2b) and across Key stage (Hypothesis 2c). It is recommended that to generalise to all secondary school students the measurement invariance of the scale should be investigated for different sub-groups such as gender, school type, and grade. For this purpose, measurement invariance of the questionnaire across gender groups, school type, and key stage is examined in this study.

Research Question 2: Does this scale satisfy measurement invariance across gender, school type, and key stage?

2. METHODOLOGY

2.1. Participants

The data was gathered from secondary school students from seven schools located in East Anglia in the UK during 2014. The questionnaire was completed by 2634 secondary school students studying in these seven schools. Properties of the seven schools are presented in Table 1.

There are four possible Ofsted ratings[†] (Ofsted Grade 1: Outstanding, Ofsted Grade 2: Good, Ofsted Grade 3: Requires Improvement, Ofsted Grade 4: Inadequate) that a school can receive. These Ofsted grades are based on inspectors' judgements across four Ofsted categories – quality of education, behaviour and attitudes, personal development of pupils, leadership and management as set out in their Education Inspection Framework last updated in 2019.

Table 1. *School type and Ofsted rating of schools taking part in the study. [1]Rating is as determined by the Office for Standards in Education, Childres's Services and Skills (Ofsted).*

School	Type	Description	Key Stages Taught	Current Ofsted rating[1]
A	*State*	Small, mixed, rural location	KS3 and 4	Good
B	*State*	Large, mixed, town location	KS3, 4 and 5	Requires Improvement
C	*State(Academy status)*	Large, mixed, city location	KS3, 4 and 5	Requires Improvement
D	*State*	Large, mixed, coast location	KS5	Good
E	*Independent*	Small, mixed, city location	KS3, 4 and 5	Outstanding
F	*State(Academy status)*	Large, mixed, rural location	KS3, 4 and 5	Special Measures
G	*State(Academy status)*	Large, mixed, town location	KS3, 4 and 5	Good

(Adapted from Yeoman *et al.* 2016)

† More information can be found in (https://thirdspacelearning.com/blog/ofsted-ratings-reports/#4-what-are-the-ofsted-ratings).

The split between male and female participants is almost equal (1134 female, 1259 male). The majority of participants were from state schools (2200 state, 434 independent). Almost an equal number of student participants were from KS3, KS4 and KS5 (see Table 2).

Table 2. *Descriptive statistics in terms of gender, school type and key stage.*

Variables	Categories	Sample(n)	Percentage
Gender	*Male*	1134	%47.38
	Female	1259	%52.62
School Type	*State*	2200	%83.52
	Independent	434	%16.48
Key Stage	*KS3(aged 11-14) Years 7, 8 and 9*	928	%35.23
	KS4(aged 14-16) Years 10 and 11	845	%32.08
	KS5(aged 16-18) Years 12 and 13	861	%32.69

(Adapted from Yeoman *et al.* 2016)

All data used in this study is publicly available. Anyone who is interested in conducting research using this data or wants to check data characteristics can access the data, without permission, on this website (http://dx.doi.org/10.5256/f1000research.7449.d108247).

2.2. Instrument

The researchers (Yeoman et al. 2016) explained how they developed this questionnaire as *'A questionnaire was designed in a series of research team meetings in the early months of the study. Starting from one of the widely-used and reliability-tested Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976; Wikoff & Buchalter, 1986), 25 items were constructed around the four themes who does research, the value of research, the process of research, and myself and research (6, 4, 9 and 6 items respectively). Attention was given to the inclusion of both positive and negative statements. Seven schools located in East Anglia participated (Table 1). The questionnaire was piloted to about 600 pupils in School C'* (p.4).

The final version of the questionnaire consists of 25 items that are divided into four main themes who does research, the value of research, the process of research, and myself and research (6, 4, 9, and 6 items respectively). The questionnaire uses a 5-point Likert-type scale (*1 = strongly agree, 3 = neither agree nor disagree, 5 = strongly disagree*). The researchers included both positive and negative statements together. Q4, Q5, Q8, Q11, and Q18 behaved as negative statements in the questionnaire (see Appendix Table A1). In Table 3, certain information including factors, number of items, and sample items within each factor are provided.

Table 3. *Factors, number of items, and sample items.*

Factors	Number of items (N)	Sample item
who does research	6 items (Q1, Q7, Q10, Q17, Q21,Q24)	Q1. Scientists do a lot of research.
the value of research	4 items (Q2, Q3, Q5, Q18)	Q2. Research is a worthwhile activity.
the process of research	9 items (Q9, Q12, Q13, Q14, Q15, Q16, Q19, Q20, Q22)	Q14. Research involves collecting new data.
myself and research	6 items (Q4, Q6, Q8, Q11, Q23, Q25)	Q6. I am confident that I can do research.

2.3. Analytical Strategy

Our analytical strategy in this study is divided into three steps: confirmatory factor analysis (CFA), correlation and internal consistency (reliability), and multi-group confirmatory factor analysis (MG-CFA).

Confirmatory factor analysis: In the main study, the scale consisted of a four-factor structure, consisting of who does research, the value of research, the process of research, and myself and research. To verify this four-factor structure, confirmatory factor analysis (CFA) was implemented on the original dataset of the sampled secondary school student groups. CFA model fit was evaluated using four traditional fit indexes. These indexes are commonly used to assess the latent construct of variables. Firstly, we use the Comparative Fit Index (CFI) and the Tucker-Lewis index (TLI) as goodness of fit statistics[the traditional cut-off value for a good model fit, (CFI) and (TLI) should be taken into account as 0.90 or higher]. We also use the root-mean-squared error of approximation (RMSEA) and the standardized root-mean-squared residual (SRMR) as residual fit statistics [the traditional threshold value for an acceptable model, (RMSEA) and (SRMR) is 0.80 or less] (Hu & Bentler, 1999; Kline, 2011).

Correlation and internal consistency: To investigate the patterns between factors and reliability within each factor, correlation, and internal consistency were tested. For correlation, Cohen (1988) suggested the cut-off point as $r \geq .224$ to identify if the correlation effect size is at least moderate. For internal consistency, reliability (internal consistency) was evaluated using Cronbach's alpha coefficient (Cronbach, 1951). This coefficient ranges from 0 to 1, with values close to 1 indicating high levels of reliability.

Multigroup invariance tests: The measurement invariance of secondary students' perception of the 'what research is' measurement model was examined across gender, school type, and key stage using multi-group confirmatory factor analysis technique (MG-CFA) (Jöreskog, 1971). In the present study, measurement invariance was investigated by running a series of statistical analyses in the subsequent order –configural, metric, and scalar invariance (Meredith, 1993; Vandenberg and Lance, 2000). This is to test if the same construct is measured and if the items of the construct are treated in the same way across subgroups (gender, school type, and key stage). The first level is configural invariance which means the same items load on the same latent variables across sub-groups. The second level is metric invariance which means factor loadings of the latent variables are constrained to be equal across sub-groups. The third and last level is scalar invariance which means the items are constrained to have the same intercepts across sub-groups. He and van de Vijver (2012, p.12) stated that "individuals who have the same score on the latent construct would obtain the same score on the observed variable regardless of their groups".

Scalar invariance is the required condition to make valid comparisons of means of the latent construct across sub-groups.

In the literature, there are two acknowledged approaches commonly used to examine measurement invariance – one is the chi-square (χ^2) test and the other is changes in CFI and RMSEA statistics (ΔCFI and ΔRMSEA) (Cheung & Rensvold, 2002)– Employing the chi-square test to determine the overall model fit is maintained to be unsuitable due to being very sensitive to large sample sizes (Tabachnick & Fidell, 2001). Thus, the ΔCFI and ΔRMSEA values were taken into account to assess measurement invariance. The cut-off criteria (ΔCFI $\leq$ 0.01, ΔRMSEA $\leq$ 0.015) recommended by Chen (2007) and Cheung and Rensvold (2002) were used to test metric and scalar invariance.

In this study, all analyses were run in R statistical software (R Core Team, 2019) using the *lavaan* (Rosseel, 2012) and *semPlot* (Epskamp, 2015) packages.

3. RESULTS

3.1. Preliminary Analysis

First, as Q4, Q5, Q8, Q11, and Q18 behaved as negative statements in the questionnaire (see Appendix Table A1), these questions were reverse coded. Data were screened to check multivariate assumptions (normality, linearity, homogeneity, and homoscedasticity). For missing data value analysis, according to the suggestion by Tabachnick and Fidell (2001), cases with more than 5% item non-responses were extracted. This resulted in the removal of 275 cases. The rest of the missing data values were replaced using multiple imputation chained equations with the *mice* package (Buuren & Groothuis-Oudshoorn, 2010). This technique has flexibility in dealing with different types of variables such as binary, categorical, and continuous (Hughes *et al*., 2014). A Mahalanobis distance ($\chi^2(28) = 56.89$) was used to detect multivariate outliers. One hundred and sixteen cases were removed using these criteria. All other assumptions were met although there were slight problems with heteroscedasticity. For further analyses, this study continued with observations from 2243 participants.

3.2. Confirmatory Factor Analysis

In Table 4, the CFA results showed that the hypothesized four-factor structure was not verified with the original secondary school student sample (Hypothesis 1) as the CFI and TLI values are less than the 0.90 cut-off suggested by Hu and Bentler (1999). The CFA unstandardized and standardized factor loadings are shown in Table 5. For standardized factor loadings, Tabachnick and Fidell (2001) stated that the correlation should be at least 0.30 or higher as lower would suggest a very weak relationship between the variables. Most standardized factor loadings were higher than 0.30, with the exception of Q4 and Q8 on the 'myself and research' factor; Q12, Q15, Q20, and Q22 on the 'process of research' factor. Therefore, these questions were removed, and a confirmatory factor analysis was then run with the remaining items.

Table 4. *Confirmatory Factor Analysis Model Fit.*

Fit statistics	Chi-sqaure	df	CFI	TLI	RMSEA	SRMR
Secondary school students (*n*=2243)	2204.611	269	0.732	0.701	0.057	0.059

Note: df = degree of freedom; CFI = Comparative Fit index; TLI = Tucker-Lewis index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual.

Table 5. *Unstandardized and Standardized Factor Loadings for Confirmatory Factor Analysis.*

Factors	Items	Unstandardized Factor Loadings	Standardized Factor Loadings
who does research	Q1	1	0.579
	Q7	1.077	0.602
	Q10	0.736	0.306
	Q17	0.911	0.427
	Q21	1.112	0.522
	Q24	0.713	0.321
the value of research	Q2	1	0.501
	Q3	1.095	0.575
	Q5	1.223	0.512
	Q18	1.070	0.557
the process of research	Q9	1	0.525
	Q12	0.669	**0.254**
	Q13	0.861	0.364
	Q14	0.828	0.332
	Q15	0.468	**0.169**
	Q16	1.055	0.490
	Q19	1.061	0.550
	Q20	0.703	**0.247**
	Q22	-0.258	**-0.085**
myself and research	Q4	1	**0.117**
	Q6	3.474	0.611
	Q8	0.645	**0.089**
	Q11	2.390	0.382
	Q23	2.776	0.434
	Q25	3.352	0.559

A new confirmatory factor analysis was executed to investigate the factor structure of the 'what research is' scale in this sample. In Table 6, the CFA results indicated that the four-factor structure was confirmed with this sample (Hypothesis 1) as the CFI and TLI were just about within an acceptable range, around 0.90. The RMSEA and SRMR were less than the 0.80 cut-off suggested by Hu and Bentler (1999). Overall, the results of the confirmatory factor analysis indicated that the fit indexes were within an acceptable range. The CFA unstandardized and standardized factor loadings are presented in Table 7. The standardized factor loadings of each item were higher than 0.30 as suggested by Tabachnick and Fidell (2001). Lastly, the measurement model including parameter estimates is provided in Figure 1.

Table 6. *Confirmatory Factor Analysis Model Fit.*

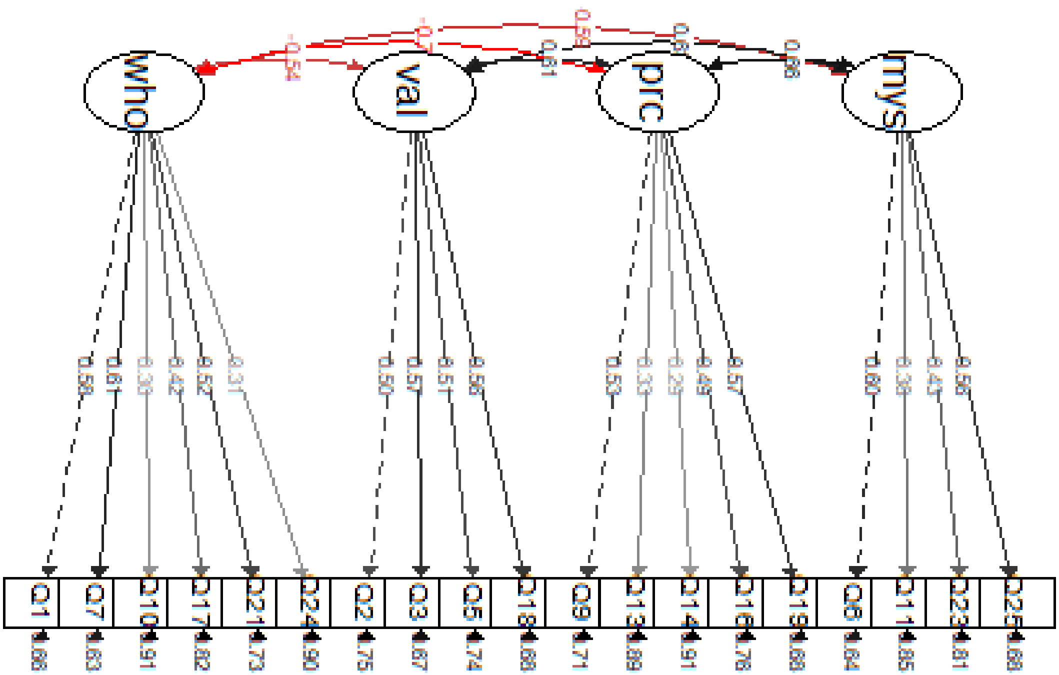
Fit statistics	Chi-square	df	CFI	TLI	RMSEA	SRMR
Secondary school students (*n*=2243)	756.264	146	0.891	0.873	0.043	0.037

Note. df = degree of freedom; CFI = Comparative Fit index; TLI = Tucker-Lewis index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual.

Table 7. *Unstandardized and Standardized Factor Loadings for Confirmatory Factor Analysis.*

Factors	Items	Unstandardized Factor Loadings	Standardized Factor Loadings
who does research	Q1	1	0.581
	Q7	1.085	0.609
	Q10	0.723	0.302
	Q17	0.892	0.420
	Q21	1.110	0.523
	Q24	0.693	0.313
the value of research	Q2	1	0.498
	Q3	1.098	0.574
	Q5	1.230	0.512
	Q18	1.085	0.561
the process of research	Q9	1	0.535
	Q13	0.773	0.333
	Q14	0.714	0.292
	Q16	1.038	0.491
	Q19	1.079	0.570
myself and research	Q6	1	0.598
	Q11	0.702	0.381
	Q23	0.816	0.434
	Q25	0.994	0.563

Figure 1. *Measurement model including parameter estimates.*



3.3. Correlation and Internal Consistency

In Table 8, Cronbach's alpha values of the four dimensions were within a somewhat reasonable range (ranging from 0.53 to 0.63), and factor correlations for the secondary school students sample were within a moderate range (0.21 to 0.37).

Table 8. *Factor Correlations, Descriptive Statistics and Cronbach's Alpha Values of the sub-scales.*

	who does research	the value of research	the process of research	myself and research
who does research	1			
the value of research	0.22	1		
the process of research	0.29	0.34	1	
myself and research	0.21	0.37	0.35	1
Max	24	17	19	16
Min	9	4	5	4
Mean	15.86	8.08	10.19	7.1
SD	2.31	2.28	2.15	1.93
Cronbach alpha (α)	0.63	0.62	0.53	0.56

3.4. Multigroup Invariance Tests

In addition to confirmatory factor analysis, measurement invariance analysis was performed to investigate if the 'what research is' measurement model was identical for gender, school type, and key stage groups (see Table 9, Table 10, Table 11).

In Table 9 we first examine configural invariance for gender groups. Configural invariance tests whether the same factor structure holds across gender. The results indicated that fit indexes were within an acceptable range. In our second step of measurement invariance, metric invariance was investigated to see if the factor loadings were identical across gender groups. The results revealed that the general adjustment measures were within acceptable ranges. In the metric invariance model, the changes in the CFI and RMSEA values were within acceptable criteria as specified by Chen (2007) and Cheung and Rensvold (2002). This result suggested that the factor loadings were identical across gender groups. CFI reduced from 0.89 to 0.86 when moving from the metric invariance model to the scalar invariance model, which is higher than the expected values. This finding indicated that the intercepts were not invariant across gender groups in the gender model.

Table 9. *MGCFA Results across Gender.*

Level of invariance	Chi-Square	df	CFI	TLI	RMSEA	SRMR	ΔCFI	ΔRMSEA
Baseline model	756.264	146	0.891	0.872	0.043	0.037		
Configural invariance	912.735	292	0.89	0.871	0.043	0.038		
Metric invariance	923.39	307	0.891	0.878	0.042	0.039	0.001	-0.001
Scalar invariance	1106.859	322	0.861	0.852	0.046	0.043	-0.03	0.004

Note: CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; ΔCFI = Change in values of CFI; ΔRMSEA = Change in values of RMSEA.

In Table 10, our first step is to examine configural invariance for school type groups. We use configural invariance to test whether the same factor structure holds across school type groups. Configural invariance results showed that fit indexes were within an acceptable range. For our second step of measurement invariance, metric invariance was examined to see if the constraining factor loadings were equal across school type groups. This result showed that the general adjustment values were within acceptable ranges. For metric invariance we found that changes in the CFI and RMSEA measures were within acceptable criteria set out by Chen (2007) and Cheung and Rensvold (2002). This finding suggested that the factor loadings were equal across school type groups. The CFI value decreased from 0.89 to 0.87 from the metric invariance model to scalar invariance model, which was not within an acceptable range. This finding revealed that the thresholds were not invariant across school type groups in the school type model.

Table 10. *MGCFA Results across School Type.*

Level of invariance	Chi-Square	df	CFI	TLI	RMSEA	SRMR	ΔCFI	ΔRMSEA
Baseline model	756.264	146	0.891	0.872	0.043	0.037		
Configural invariance	887.003	292	0.894	0.876	0.042	0.037		
Metric invariance	902.531	307	0.894	0.882	0.041	0.038	0	-0.001
Scalar invariance	1027.59	322	0.874	0.867	0.044	0.04	-0.02	0.003

Note: CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; ΔCFI = Change in values of CFI; ΔRMSEA = Change in values of RMSEA.

In Table 11 we first examine configural invariance across key stage groups. Configural invariance is used to test whether the same factor structure holds across key stage groups. Configural invariance results indicated that fit indexes were within an acceptable range. As the second step of measurement invariance, metric invariance was investigated to see if the factor loadings were identical across key stage groups. These results showed that the general adjustment measures were within acceptable ranges. Moving from the configural invariance model to the metric invariance model, the changes in the CFI and RMSEA measures were within the acceptable criteria set out by Chen (2007) and Cheung and Rensvold (2002). This finding indicated that the factor loadings were identical across key stage groups. CFI was reduced from 0.87 to 0.84 when moving from the metric invariance to the scalar invariance model, which was not within acceptable criteria. This finding revealed that the intercepts were not invariant across key stage groups in the key stage model.

Table 11. *MGCFA Results across Key Stage.*

Level of invariance	Chi-Square	df	CFI	TLI	RMSEA	SRMR	ΔCFI	ΔRMSEA
Baseline model	756.264	146	0.891	0.872	0.043	0.037		
Configural invariance	1118.68	438	0.88	0.86	0.045	0.042		
Metric invariance	1159.21	468	0.879	0.867	0.044	0.045	-0.001	-0.001
Scalar invariance	1405.52	498	0.841	0.836	0.049	0.05	-0.038	0.005

Note: CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; ΔCFI = Change in values of CFI; ΔRMSEA = Change in values of RMSEA.

4. DISCUSSION

The present study aimed to quantitatively validate secondary students' perception of the 'what research is' scale developed by Yeoman et al. (2016) using the dataset orginally used to qualitatively validate the scale. The scale was comprehensively developed qualitatively at the beginning of its development process but had not yet been quantitatively validated. In order to empirically validate the scale the factor structure was investigated, reliability analyses of the sub-scales were carried out, and measurement invariance for gender groups, school type groups, and key stage groups were examined.

Providing quantitative evidence for the proposed four-factor structure model of secondary school students' perceptions of the 'what research is' scale was essential to improve the scale's robustness and validity. First, the data from the original sample of secondary school students' did not fully fit to the proposed four-factor structure. Nineteen items out of twenty-five were loaded reasonably acceptably on relevant unobserved factors with all factor loadings higher than 0.30. Four items –*Q12.Research involves coming up with new theories, Q15. Research always involves investigating a question, Q20. You do research to confirm your own opinion, Q22. Research is carried out solely through experiments in a laboratory* – from the *process of research* factor and two items –*Q4. People around me would not take me seriously if I said I was interested in a career in research and Q8. Doing research is challenging* – from the *myself and research* factor loaded very weak (lower than 0.30) factor loadings on their factors. Second, after omitting these items from the questionnaire, new confirmatory factor analysis was performed to verify the proposed four-factor structure model with the rest of the nineteen items. The secondary school student data demonstrated an acceptable fit to the proposed four-factor structure. The revised version of the secondary school student perception of the 'what research is' scale was provided in Appendix Table A2.

We found reasonably moderate correlations between factors for the factor correlations patterns. The highest factor correlations between *myself and research* and *the value of research* (r = 0.37) and the lowest factor correlation patterns were found between 'who does research' and 'myself and research' (r = 0.21). The reliability analysis of each dimensions showed that every factor demonstrates a relatively moderate alpha (ranging from 0.63 to 0.53) probably due to having relatively moderate item factor loadings to some degree. Future studies may investigate this issue by either deleting some items or checking other combinations in relation to the theoretical foundations of what research is.

Supporting evidence concerning the equivalence of the factor structure of secondary school students' perception of the 'what research is' scale with its original dataset would increase the feasibility of the 'what research is' scale in comparing students' perceptions about what research is across gender groups, school type groups, and key stage groups. To examine the measurement invariance at three hierarchical levels across gender, school type, and key stage, respectively, the configural, metric, and scalar invariance models were compared. The findings revealed that there were no significant differences between fit indexes at configural and metric level invariance, but there was scalar level invariance across gender, school type, and key stage. Thus, the British sample data satisfied the full configural and metric level invariance model but did not satisfy the scalar invariance model. These findings showed that whilst the scale had the same pattern structure and factor loadings it did not show the same item intercepts across gender, school type, and key stage. The scale allows comparisons of associations, for example, correlation and regression coefficients within gender, school type, and key stage groups. However, the mean of the scale (the average of secondary students' perception of what research is) cannot be compared between gender groups, school type groups, and key stage groups.

There is a growing body of research that has examined students' perceptions of what research is at higher education level or higher. However less attention has been paid to this at secondary level. The validation of the secondary school students' perception of the 'what research is' scale provides insights for researchers concerning secondary school students' perceptions of research. Accordingly, longitudinal studies could be designed to observe students' future career paths.

4.1. Limitations

This study has limitations that should not be ignored. In the current study, all analyses were performed using the original sample of 2634 secondary school students from seven schools located only in East Anglia in the UK. Furthermore, in this sample, the majority of participants were state school students (2000 state school students, 434 independent school students), this distribution might give rise to some difficulties in terms of generalizability. To increase the generalizability of these research findings in England, the secondary school students' perception of the 'what research is' scale should be implemented in larger samples drawn from other parts of England using an even school type distribution.

Although this current study contributed some concrete evidence that this scale is reliable and valid in an English sample, the secondary school students' perceptions of the 'what research is' scale should be investigated to determine its reliability and validity in different cultures and countries. In the present study, measurement invariance was investigated regarding gender, school type, and key stage. Future research should investigate measurement invariance across age groups, ethnicity, culture, and country as well as gender, school type, and key stage to provide more robust and valid evidence on this scale.

4.2. Conclusion

In this study, secondary school students' perceptions of the 'what research is' scale were validated using the original dataset that was used to comprehensively validate the scale qualitatively. The reliability results showed that the 'what research is' scale can be used to assess secondary school students' perception of what research is as a moderately reliable measurement instrument. The validity results demonstrated a good fit for the "what research is" scale, which confirms the four-factor structure. The structure includes, who does research, the value of research, the process of research, and myself and research after extracting some items. Furthermore, measurement invariance results indicated that the 'what research is' scale has equivalence at metric invariance level across gender, school type, and key stage. Therefore, comparisons should be made cautiously across gender, school type, and key stage regarding secondary school students' perceptions of what research is.

In conclusion, the current study should be considered as a starting point to paying attention to early years students' perceptions of what research is and whether it can predict future career aspirations.

Declaration of Conflicting Interests and Ethics

The author declares no conflict of interest. This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in IJATE belongs to the author.

Authorship Contribution Statement

Author 1: Investigation, Resources, Visualization, Software, Formal Analysis, and Writing - original draft.

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6. APPENDIX

Table A1. Original questionnaire

University of East Anglia — School University Partnership Programme

Male ☐	Year 7 ☐	Year 10 ☐	Year 12 ☐	***We thank you very much for taking the time to help us with our research!*** *Kay Yeoman, Project Director*
Female ☐	Year 8 ☐	Year 11 ☐	Year 13 ☐	
	Year 9 ☐	State School ☐	Independent School ☐	

This short questionnaire aims to explore your views on what is research, who uses it, how it is conducted, whether you see it as something useful and enjoyable, and as something that you are good at and interested in. We expect this to take no longer than 15 minutes to complete.

Please shade the box 1, 2, 3, 4 or 5, with **1** standing for **Strongly Agree** and 5 for **Strongly Disagree**. Shade 3 if you neither agree nor disagree, or if you are unsure.

	Statement	**1**	**2**	**3**	**4**	**5**
1.	Scientists do a lot of research.	☐	☐	☐	☐	☐
2.	Research is a worthwhile activity.	☐	☐	☐	☐	☐
3.	Knowing how to do research will help me in my future career.	☐	☐	☐	☐	☐
4.	People around me would not take me seriously if I said I was interested in a career in research.	☐	☐	☐	☐	☐
5.	Research will not be important in my life's work.	☐	☐	☐	☐	☐
6.	I am confident that I can do research.	☐	☐	☐	☐	☐
7.	Historians do a lot of research.	☐	☐	☐	☐	☐
8.	Doing research is challenging.	☐	☐	☐	☐	☐
9.	Research can be carried out through collecting data during a fieldtrip.	☐	☐	☐	☐	☐
10.	Artists do a lot of research.	☐	☐	☐	☐	☐
11.	You have to be a genius to do research.	☐	☐	☐	☐	☐
12.	Research involves coming up with new theories.	☐	☐	☐	☐	☐
13.	The main purpose of research is to generate new knowledge.	☐	☐	☐	☐	☐
14.	Research involves collecting new data.	☐	☐	☐	☐	☐
15.	Research always involves investigating a question.	☐	☐	☐	☐	☐
16.	Research involves searching through sources, such as libraries.	☐	☐	☐	☐	☐
17.	Philosophers do a lot of research.	☐	☐	☐	☐	☐
18.	Doing research is not useful.	☐	☐	☐	☐	☐
19.	Research can involve collecting data through interviews and questionnaires.	☐	☐	☐	☐	☐
20.	You do research to confirm your own opinion.	☐	☐	☐	☐	☐
21.	Lawyers do a lot of research.	☐	☐	☐	☐	☐
22.	Research is carried out solely through experiments in a laboratory.	☐	☐	☐	☐	☐
23.	Anybody can do research.	☐	☐	☐	☐	☐
24.	Mathematicians do a lot of research.	☐	☐	☐	☐	☐
25.	I think I do research in school.	☐	☐	☐	☐	☐

Table A2. Revised version of the questionnaire.

Who does research

	Statement	1	2	3	4	5
1.	Scientists do a lot of research.	☐	☐	☐	☐	☐
7.	Historians do a lot of research.	☐	☐	☐	☐	☐
10.	Artists do a lot of research.	☐	☐	☐	☐	☐
17.	Philosophers do a lot of research.	☐	☐	☐	☐	☐
21.	Lawyers do a lot of research.	☐	☐	☐	☐	☐
24.	Mathematicians do a lot of research.	☐	☐	☐	☐	☐

The value of research

2.	Research is a worthwhile activity.	☐	☐	☐	☐	☐
3.	Knowing how to do research will help me in my future career.	☐	☐	☐	☐	☐
5.	Research will not be important in my life's work.	☐	☐	☐	☐	☐
18.	Doing research is not useful.	☐	☐	☐	☐	☐

The process of research

9.	Research can be carried out through collecting data during a fieldtrip.	☐	☐	☐	☐	☐
13.	The main purpose of research is to generate new knowledge.	☐	☐	☐	☐	☐
14.	Research involves collecting new data.	☐	☐	☐	☐	☐
16.	Research involves searching through sources, such as libraries.	☐	☐	☐	☐	☐
19.	Research can involve collecting data through interviews and questionnaires.	☐	☐	☐	☐	☐

Myself and research

6.	I am confident that I can do research.	☐	☐	☐	☐	☐
11.	You have to be a genius to do research.	☐	☐	☐	☐	☐
23.	Anybody can do research.	☐	☐	☐	☐	☐
25.	I think I do research in school.	☐	☐	☐	☐	☐