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Examining the gender-gap in STEM-field career expectations among 15-year-old students

Abstract

The gender-gap in graduation rates in Science, Technology, Engineering and Mathematics (STEM) continuous to puzzle social scientists and policymakers, as women are still underrepresented in these fields. A further puzzle exists in the relationship between graduation rates and a country's ability to ensure equal opportunities for men and women, where an increase in the gender-equality gap index is associated with fewer women graduating in STEM-fields. This paper sets out to investigate whether a similar relationship can be found in the career-expectations of 15-year-old students using data from Program for International Student Assessment (PISA) 2015-survey. The research focuses on postmaterialism as the predictor, and how post-materialistic societies promote values that will manifest themselves in micro-level behavior. A Cross-level moderated mediation analysis shows that students in post-materialistic societies who have reading as their personal best subject are less likely to expect a STEM-field career. The research also shows that the increasing gender-gap in more post-materialistic countries cannot be ascribed to differences in science-abilities or efficacy in science between boys and girls.

Keywords: Gender, STEM, Education, Postmaterialism, PISA,

Introduction

The gender gap in STEM-field occupations, especially those considered as "hard sciences" such as engineering, mathematics and computer science has been an increasingly salient issue for social scientists and policymakers as the demand for skilled workers in these fields is increasing (OECD 2017b; Stoet & Geary 2017; Wang & Degol 2013) and a gender-gap in graduation rates continuous

to exist. The efforts of eradicating gender segregations in educational attainments and occupational status have been extensive (OECD 2016a; 2017a), however the gender segregations in STEM-related careers continue to exist (OECD 2017b; OECD 2019; Stoet & Geary 2017). It is likely that more gender integration in these fields can create potential benefits, as a higher gender diversity can foster human creativity and a lack of gender integration can hamper these fields from "exploiting" the talents of all individuals with skills within engineering, mathematics and computer science. Scholars have been trying to explain the gender segregation in these fields from ability in science and mathematics alone, however, if small differences in ability that favor boys do exist (in many countries the tendency is reversed), it can't account for the gender-gap in STEM-graduations (Stoet & Geary 2017; Wang et al., 2013). This makes it even more relevant to understand what accounts for these differences in educational attainments, as potential STEM-skilled girls are retained from getting a degree in such a field.

What has further puzzled social scientists is the relationship between the proportion of women graduating from a career in STEM-fields and countries in terms of affluency and gender-equality. The relationship suggests that in what are considered as post-materialistic and gender-equal countries, such as Finland, Sweden, and Norway fewer women graduate from STEM-fields than in less affluent and less gender equal countries, where the gender segregation is smallest (OECD 2019; Stoet & Geary 2017). Moreover, the expectations of pursuing a STEM-related career among children and adolescents follow the same pattern, where the gender-segregation in expecting a career in STEM is largest in gender-equal and affluent societies (Charles et al., 2014; Sikora & Pokropek 2012). This can seem paradoxical as the gender-equality index of a country, among other things, is measured by the country's ability to ensure equal opportunities between females and males in educational attainments. It also stands in contrast to theories of societal development and modernization, that argue that in more modern societies, the effects of ascribed characteristics such as socio-economic status and gender will become smaller, and therefore lead to a higher gender integration in educational attainments (Marks 2010).

This research sets out to examine whether the same paradoxical observation can be found in 15-year-olds career expectations for when they are 30 years old, and if so, what the possible mechanisms for this observation could be, using data from Program for International Student Assessment (PISA) 2015-survey. As Stoet & Geary note in their study of the relationship between countries' gender equality index and graduation rates of women, the countries that achieve a high gender-equality score

also tend to be more affluent societies (Stoet & Geary 2017). This study therefore focuses on economic development or postmaterialism as the predictor.

The macrolevel phenomenon is sought explained causally by microlevel behaviors and actions, as these individual actions are assumed to manifest themselves in outcomes on the macrolevel. The research will examine two plausible mechanisms for why the gender-gap in STEM-field graduation is largest in more post-materialistic countries. Drawing from literature on gender-essentialist ideology (Charles & Grusky 2004; Charles et al. 2014) accompanied by self-assessment bias theorized by Shelley Correll and others (Correll 2001; Sikora & Pokropek 2012), the paradox is sought explained by the plausible increase of gender-essentialist ideologies in post-materialistic countries and girls' biased assessment of their own abilities. The second possible mechanism will draw on literature from expectancy-value theory, that seek to explain educational and career choices by the individual's belief that he or she can do well in the specific field, and the subjective values that he or she attach to pursuing the field (Bøe & Henriksen 2015; Wigfield & Eccles 2000). The subjective values, that individuals attach to career choices, are argued to be different in post-materialistic countries and more materialistic countries (Charles et al., 2014; Sikora & Pokropek 2012). The two mechanisms are not mutually exclusive but are considered as two plausible pathways that can account for the larger gender segregation in post-materialistic countries. Both approaches will be accompanied by literature on postmaterialism theorized by Ronald Inglehart and others (Inglehart 1977; Inglehart & Norris 2003).

Mechanisms

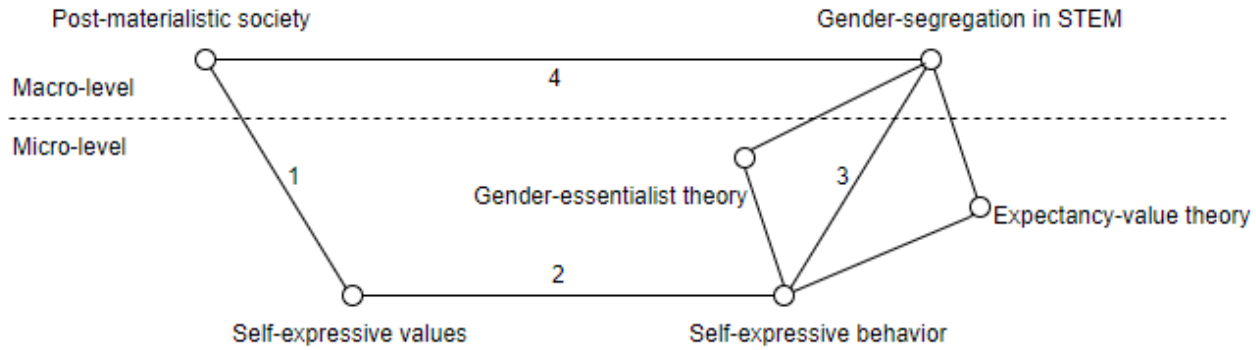

Figure 1

The figure functions to illustrate the causal path within a methodological individualistic understanding of a macro-level social phenomenon (Coleman 1990). The macro-level association is sought explained causally through the values internalized in a certain context that subsequently will manifest themselves in actions caused by these internalized values and beliefs. This research seeks to

investigate the third mechanism in the model, namely how the (self-expressive) values are expressed through social behavior, which then result in the macro-level phenomenon. The research will undergo two plausible mechanisms in which self-expressive values will manifest themselves in a certain kind of behavior, namely through gender-essentialist theory and expectancy-value theory. A first step of the research is to identify whether the gender-segregation in STEM-field graduations also can be elucidated in 15-year-old students' expected occupations when they are 30 years old (Hypothesis 1).

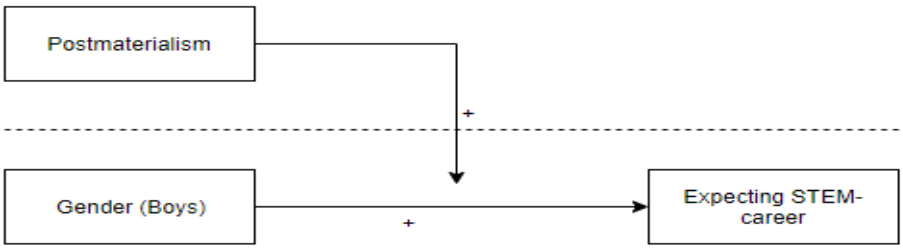

Figure 2. Hypothesis 1.

Gender essentialism and Self-assessment bias

The gender-gap in both manual occupational fields and in STEM-related fields such as, mathematics, engineering and computer science are still a puzzle to social scientists, as these gaps continue to exist in even the most liberal and gender egalitarian countries (OECD 2017b; Stoet & Geary 2017; Charles et al., 2014;). David Grusky and Maria Charles give a plausible account for why this gap is existing, and why gender segregation in certain fields are resisting the egalitarian pressures which successfully enhances women to pursue high occupational jobs in other fields (2004; Inglehart & Norris 2003). They argue that stratification scholars have failed to acknowledge that gender segregation can't be conceptualized as a unidimensional phenomenon, where it is presumed that men occupy a larger proportion of high occupational statuses. This conceptualization has plausible explanatory power in certain areas such as political participation and involvement, as more liberal and gender-egalitarian countries succeed in empowering women to pursue a political career (Inglehart & Norris 2003), but it fails to account for why specific areas are more resistant to gender-egalitarian pressures. Charles & Grusky argue that gender segregation in occupational fields should rather be conceptualized in a two-dimensional space, where segregation happens either vertically or horizontally and in interactions herein (2004). They show that segregation, besides occurring on vertical or in occupational status terms, also occurs on horizontal terms as women are disproportionally allocated in non-manual occupations. To provide a plausible explanation for the horizontal segregation, Charles & Grusky

focuses on gender essentialist ideologies that are the beliefs and culturally shared assumptions that women are naturally better at tasks that involves nurturing, personal service and social interaction, whereas men are believed to be more capable of performing analytical and problem-solving tasks. These widely shared assumptions, Charles & Grusky argue, should manifest themselves in the occupational choices boys and girls choose to pursue and are found to be more present in the most liberal countries (2004; Charles & Bradley 2009). A possible explanation for why boys and girls are more likely to have gender essentialist beliefs in more liberal and affluent countries is found in the literature on postmaterialism. In post-materialistic countries individuals are more likely to adhere to self-expressive values and behavior of self-fulfillment because materialistic and economic concerns to a large extent can be ignored (Inglehart 1977; Charles et al., 2014). These self-expressive values are argued to still be highly gendered and will therefore become more prevalent in societies where individuals are predominantly adhering to post-materialistic values. A self-segregation will thus occur more prevalent in more liberal post-materialistic societies (Charles et al., 2014; Sikora & Pokropek, 2011).

Gender-essentialist beliefs will likely manifest themselves in how individuals assess their own abilities in what is perceived as being mainly "male" activities. If gender essentialist beliefs are present in a society, girls will therefore be assessing their own abilities in the fields of science in a biased manner regardless of their actual abilities (Correll 2014). The mechanism for this is that girls in a post-materialistic society with prevailing gender-essentialist beliefs would perceive boys to be naturally better at tasks within a field of problem-solving and analytical tasks, and girls will therefore show a lower efficacy in those tasks regardless of their actual abilities (Hypothesis 1a).

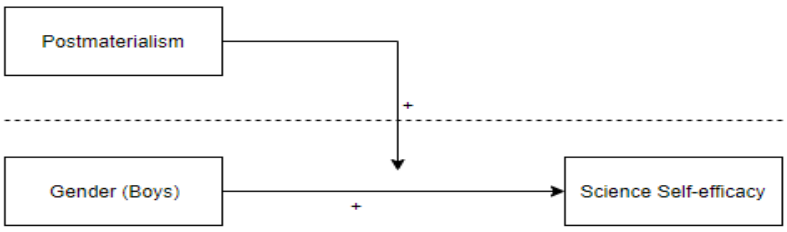

Figure 3. Hypothesis 1a

For the mechanism to be present, girls will also be more likely to show an increase in efficacy if they are provided with positive feedback from their peers. This is due to their biased self-assessment, and the believe that boys are naturally better at science-related tasks. Boys on the other hand will perceive

themselves to be “naturally” gifted in these fields and will therefore not react to external positive feedback in the same degree as girls (Correll 2014) (Hypothesis 2a).

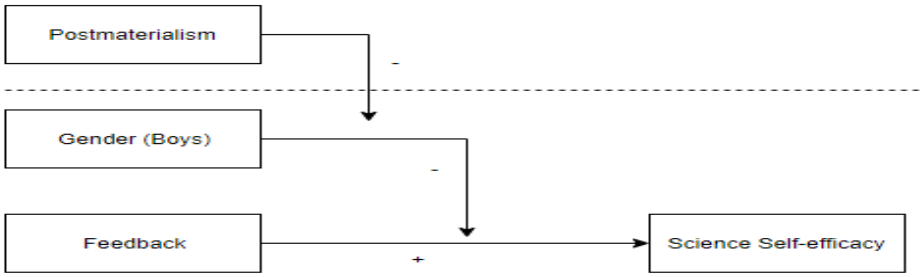

Figure 4. Hypothesis 2a

For this to be attributed to the gender gap in expectations of pursuing a STEM-field occupation two other assumptions must also be met, namely a positive relationship between self-efficacy in science and pursuing a STEM-field career (Hypothesis 3a), and that postmaterialism moderates the indirect effect of gender and self-efficacy (hypothesis 4a) in the mediation analysis shown in figure 5.

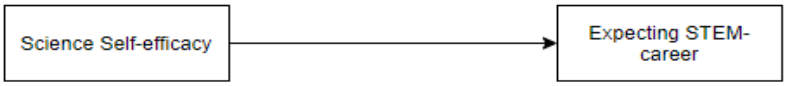

Figure 5. Hypothesis 3a.

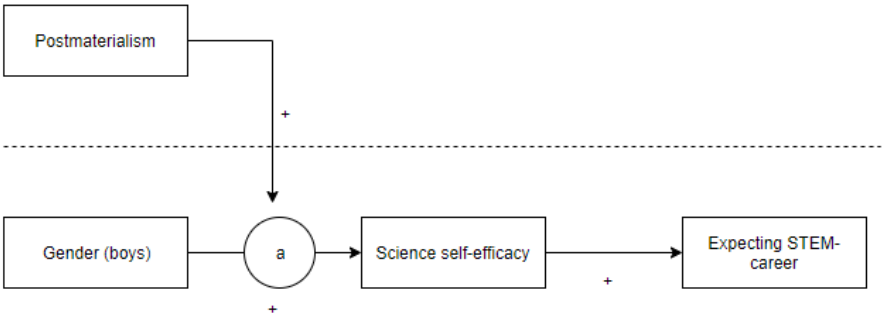

Figure 6. Hypothesis 4a.

Expectancy-value theory

The expectancy-value theory tries to provide mechanisms for educational and career decision-making of young people that is based on different forms of motivations. It has both psychological and

sociological components and scholars of these disciplines have been investigating the explanatory power of the expectancy-value theory in predicting educational paths of young adolescents (Bøe & Henriksen 2015; Wang & Degol 2013; Wigfield & Eccles 2000). The theory seeks to explain the educational decision-makings of young adolescents, where the mechanisms consist of how well the individuals believe that they will do well in a certain field (expectations of success) and the subjective value individuals attach to the educational field (interests, utility and relative cost) (Bøe & Henriksen 2015; Wigfield & Eccles 2000). The expectations of success include both the actual ability and the self-efficacy an individual has toward a certain task and combines therefore both objective merits and subjective self-efficacy and the relation between the two. The second component makes up the subjective gains an individual receives in attaining a certain field of study. These include the interests an individual has in the subject as a motivating factor for pursuing a career within such a field. The utility a person has for pursuing a certain field is also a determining factor when choosing educational path where utility can be conceptualized both as intrinsic and extrinsic utility. The relative cost as a motivational factor refers to the perceived difficulty or other negative aspects that an individual attribute to pursuing a certain educational path (Bøe & Henriksen 2015).

In this research the focus will be on both components, and especially on objective merits of ability and on the subjective utility one attributes to pursuing a certain career-path and how these two subsets interact.

In this mechanism, plausible for accounting for the gender-segregation in the STEM-fields, the values attached to individuals in post-materialistic societies are also in center albeit in a different manner. As argued above, individuals in post-materialistic countries put emphasis on self-realizing and self-expressive values and tend to emphasize economic and material concerns to a lesser degree (Inglehart 1977; Charles et al., 2014). In more post-materialistic countries it is therefore likely that the adolescents will pursue an educational and occupational career in which intrinsic gains, in form of self-realization and self-expression, would weigh higher than choosing a field that could provide external materialistic gains. Personal gains of self-fulfillment will arguably be in those tasks in which an individual shows greatest ability in, as this provides the efficacy of believing one can personally excel in it. This will be regardless of economic gains, as personal self-development and self-realization arguably will be the most determining factors in post-materialistic societies. In a society predominated by materialistic values, however, the utility of attaining an educational path can be argued to be determined more by extrinsic values in form of materialistic gains, and intrinsic self-realization would matter less. A career in a STEM-related field fulfils such a requirement as it is

considered to be some of the best-paid occupations (OECD 2017b). The scarcity and the high demand of individuals with skillsets within these fields would thus further increase one's "labor-market value". Studies have shown that differences in abilities between boys and girls in science- and mathematic-related tasks are small - in some countries in favor of boys and others in favor of girls. However, when girls show high abilities in science-tasks they show even greater abilities in subjects related to reading, whereas boys who show high science-abilities tend to also have science as their relative best subject (Stoet & Geary 2017). The argument is thus, that these differences of boys' and girls' relative best subject will manifest themselves in expected careers in post-materialistic countries, as individuals would have greater chances of pursuing a field in which they can achieve personal self-realization. Girls in societies with predominately materialistic values would be more inclined to pursue a career that is economically advantageous such as the STEM-fields, regardless of having an academic strength in another domain. Two hypotheses can thus be derived from the line of argumentation above; girls will across countries have reading as their relative best subject (Hypothesis 1b), and postmaterialism will moderate the indirect effect of having reading as the relative best subject and expecting a STEM-career in the mediation analysis (Hypothesis 2b) shown in figure 8.

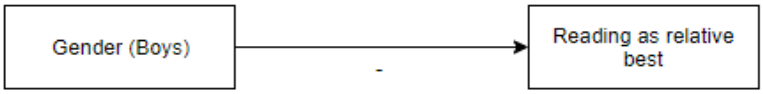

Figure 7. Hypothesis 1b.

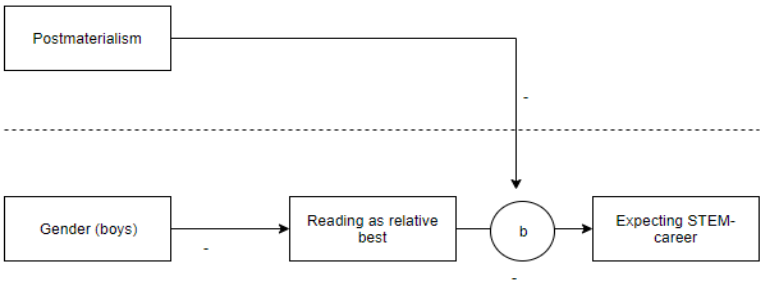

Figure 8. Hypothesis 2b

Data, Measurement and Methods

The Program for International Student Assessment (PISA) 2015-surveys aims to elucidate what challenges 15-year-old student face in today's societies and how they perform in reading-,

mathematics-, and science-subjects. The PISA surveys are conducted every third year and has functioned as a tool to compare schools and countries since 2000. Every year the focus is either on reading, mathematics or science and in 2015 the focus was on science (OECD 2017c). 35 OECD countries and 37 partner countries participated in the 2015-surveys. A comprehensive overview of the methodology, scaling procedures, weighting techniques etc. can be found in the PISA 2015 Technical Report (OECD 2017c).

Dependent variables

Different dependent variables will be used throughout the analysis to test all hypotheses. These variables are *Science self-efficacy, reading as relative best* and *Expecting a STEM-career. Science self-efficacy* is a constructed index of how the students perceive themselves to be able to use their knowledge in science in real-world situations. The variable is continuous and an increase in the value indicates a stronger believe in being able to understand science news reports and engage in discussions in science topics (OECD 2016b). The scale is constructed from the questions of how well the students believe they can; Recognize the science question that underlies a newspaper report on a health issue, explain why earthquakes occur more frequently in some areas than in others, describe the role of antibiotics in the treatment of disease, identify the science question associated with the disposal of garbage, predict how changes to an environment will affect the survival of certain species, interpret the scientific information provided on the labelling of food items, discuss how new evidence can lead you to change your understanding about the possibility of life on Mars and identify the better of two explanations for the formation of acid rain. The answers the students could provide for each question are; “I could do this easily”, “I could do this with a bit of effort”, “I would struggle to do this on my own” and “I couldn’t do this” (OECD 2016b). The Cronbach’s alpha of the scale is 0,87, which indicates that the questions are closely related. *Reading as relative best* is a constructed variable of the students’ individual relative best academic abilities, where an increase in the variable indicates having reading as relative best ability. The creation of the variable follows the method used by Stoet & Geary (2017). The variable *Expecting a STEM-career* is a dichotomous variable indicating whether the student expect him or herself to be in a STEM-related field at age 30, where an increase indicates that the student expects to work in a STEM at age 30. It is constructed from an open-entry variable asking the students what specific job they expect to have at age 30, the exact wording of the question is; What kind of job do you expect to have when you are about 30 years old?. Answers to this open-ended question were coded to four-digit ISCO codes (OECD 2016b). The classification of

what occupations that are considered as being STEM-fields is inspired by other studies performing same classification (Wang 2016; Sikora & Pokropek 2012) and can be found in Appendix A.

Independent variables

The independent variables used in the analysis are *Gender, Positive Feedback, Science self-efficacy* and *Postmaterialism*. *Gender* is coded 1 for females and 2 for males. *Positive feedback* is an ordinal variable created from the variable "*How often does this happen in <school science>? The teacher gives me feedback on my strengths <school science> subject"*, where the answers to the questions are; "never or almost never", "some lessons", "many lessons" and that it occurs in "every lesson or almost every lesson". *Science self-efficacy* is used as an independent variable in order to test hypothesis 3a. *Postmaterialism* is a macro-level variable with a value for each country indicating its level of postmaterialism. This variable is created by a country's Inequality-adjusted Human Development Index (UNDP 2015), inspired by other studies using this as an indicator of a country's degree of postmaterialism (Charles et al. 2014). Representative samples from 54 countries are used in the analysis, where each country has been ascribed a value according to the Inequality-adjusted Human development Index. The list of countries can be found in Appendix B. *Science self-efficacy* and *Reading as relative best* are the independent variables, hypothesized to mediate the relationship between *Gender* and *Expecting a STEM-career* at high levels of postmaterialism.

Control variables

Multiple factors can influence whether students are expecting a career in a STEM-related field. The economic status of parents has often proved to be a strong indicator of which occupational status children will end up with. The educational status, which is often operationalized in terms of "cultural capital" also appears to be a good indicator when explaining educational attainment. The PISA data provides an index that captures both these components, which is called *ESCS*. This continuous scale captures both the economic and cultural status of the parents and will function as an essential control variable throughout the analysis. The abilities in science-related subjects will also function as a control variable, which will be denoted as *science-score*. *Science-score* is a constructed scale created from the students' plausible values in their performance in science. Both control variables are continuous where an increase in both variables indicate a higher status or score in economic and cultural status and science scores.

Other control variables have been considered to be employed as well, including the actual occupations of the students' mother and father, and the expectation of parents that their child will pursue a science-career. These variables can be imagined having an influence on whether a student expects to work in STEM, as the parents' occupations might make the student consider a similar occupation. Similarly, if a student has parents that encourage or expect him or her to work in science, it can easily be imagined that this will influence the student's career-expectations. However, as these variables have a large amount of missing values it has been considered most advantageously to exclude them as control variables.

Analytical approach[1]

The analysis will be conducted by employing both simple linear regression and binary logistic regression techniques. As the analysis consists of hypotheses with both continuous and dichotomous outcome variables, the logics behind simple linear regression will be inadequate in testing all hypotheses. Hypotheses 1a and 2a and 1b deals with a continuous outcome variable in *science self-efficacy* and *reading as relative best*. For these hypotheses the logics of linear regression will be employed, where the predicted values of the outcome variable can be calculated for each value the independent variable can have. Therefore, these are intuitively easy to interpret, where the beta coefficient equals the increase in the outcome variable as a one-unit increase in the predictor variable occurs. Dealing with hypotheses 1, 3a, 4a and 2b the outcome variable is dichotomous, as it denotes whether a student expects pursuing a career in STEM (1) or not pursuing a career in STEM (0). When having a categorical dichotomous outcome variable, the theory behind linear regression models cannot be employed as it will provide predicted values for certain values of X that are unrealistic (predicted values under 0 and above 1). Instead the logics of binary logistic regression will be employed, where we are interested in elucidating the *probability* of the event occurring (pursuing a career in STEM) for a given x-value (Field 2013). A value above zero indicates that as the predictor variable increases, the probability of being in the "success-group" (expecting a STEM-career) increases, and similarly, a negative logit coefficient indicates that as values of the predictor variable increases, the likelihood of being in the "success-group" decreases.

[1] Additional information including syntax files for Mplus and SPSS analyses can be found on canvas.

Multilevel models

The present study seeks to investigate whether student-level relationships vary across countries and specifically how student-level relationships differ relatively to a country-level variable. As the research question involves two levels where variation can occur - on student-level and on country-level - multilevel modeling will be employed. Failing to do so involves risks of over- or underestimating student-level relationships as the variation that exists between countries, and which can have an influence on the student-level relationship, is not taken into account. The student- and country-level will be referred to as within- and between-level respectively.

Cross-level interaction

Cross-level interactions will be used for several of the hypotheses derived from the theories of gender essentialism and expectancy value theory. A cross-level interaction effect occurs when changes in a between-level predictor variable changes the significance or strength of a within-level relationship (Aguinis et. al 2013). The hypotheses that are to be tested in the present study expect cross-level interactions to occur, in which the between-level variable postmaterialism is theorized to affect different within-level relationships. Herman Aguinis et al. provides a framework of how to conduct a cross-level interaction model and which steps ought to be taken along the way. The present study will follow this framework and approach when conducting the cross-level interaction models. The first step in a cross-level interaction model is to create a *null-model*. This model contains only the outcome variable which estimates are assumed to vary across between-level groups when regressed on other within-level predictors. This model allows us to elucidate whether the outcome variable has variance on the between-level by calculating the Intraclass coefficient, where an ICC value, which range is 0-1, close to zero implies that the outcome variable doesn't have unexplained variance on the between-level (Aguinis et al. 2013). The outcome variables in the cross-level interaction models are *science self-effiacy* and *Expecting a STEM-career*. As *science self-efficacy* takes a continuous form, the ICC can be calculated, however for the dichotomous variable *Expecting a STEM-career*, the significance level of the between-level intercepts will function as an indicator for country-level variance.

Having established that variation in the outcome variable can be explained by between-level predictor variables, step two will be to run a random intercept and fixed slope model. In this model the within-level outcome variable is regressed on the predictor variables that are theorized to have explanatory

power. The within-level relationship slopes are in this model not allowed to vary and are assumed to be the same across countries. The model shows the mean-effect of the within-level relationship in which a significant value of the hypothesized within-level relationship can be established. The third step is to run a random intercept and random slope model. This model contains information about whether the within-level relationships vary across countries – that the predictor variable has different explanatory power across countries. This information is important when a cross-level interaction is hypothesized to occur, as the aim is to predict different effects of a within-level relationship when increases of a between-level predictor variable occurs. A significant value of the random slope will yield information about whether the slopes between countries vary. The fourth step is then to establish whether the within-level relationship can be estimated using a predictor variable on the between-level. The variable *postmaterialism* is the only country-level variable that are theorized to affect the within-level relationships, and a significant relationship when postmaterialism moderates the within-level relationship will indicate a cross-level interaction.

Moderated mediation analysis

Hypotheses 4a and 2b both entails a mediation analysis, in which two different mediators – *science self-efficacy* and *reading as relative best*, is hypothesized to have an indirect effect between *gender* and *expecting a STEM-career*. As we are interested in elucidating why the gender-gap in pursuing a STEM-field career increases as a country's level of postmaterialism increases, the indirect effects are expected to increase as values of postmaterialism increases. The two hypotheses therefore both entail cross-level moderated mediation, where hypothesis 4a predicts a moderated indirect effect between gender and science self-efficacy and hypothesis 2b hypothesize a moderated indirect effect between reading as relative best and expecting a STEM-career. Both hypotheses therefore can be considered as 1-(a)-1-(b)-1 models with a level-two moderator, the difference being that hypothesis 4a predicts a moderated mediation for path a and hypothesis 2b predicts a moderated mediation for path b.

Results

The first hypothesis that will be tested relates to whether the relationship between *Gender* and *Expecting a STEM-career* is moderated by the between-level predictor postmaterialism (figure 2). The first step will be to estimate whether there exists significant country-level variance for our

dichotomous dependent variable *Expecting a STEM-career*. Because the variable is dichotomous the model does not include within-level residuals. Therefore, a significant country-level variance for the random intercepts will function as the indicator for whether the variance of the dependent variable can be explained by country-level predictors. The between-level variance for the random intercepts is 0.211 and is indeed significant at the 99% confidence interval, which means that multilevel modeling will be employed.

The random intercept model shows that *gender* has a positive relationship with *expecting a STEM-career*, with a logit estimate of 1.655 and the relationship is significant. As the reference category in the dichotomous variable *gender* is girls, the positive coefficient shows that boys across countries are more likely to expect working in the STEM-fields in the age of 30 than girls. The random slope model shows the relationship between gender and expecting a STEM-career to be varying between countries. The hypothesized cross-level interaction in hypothesis 1 is confirmed as postmaterialism significantly moderates the level 1 relationship between *gender* and *expecting a STEM-career*. This means that the likelihood of boys expecting a career in STEM in relation to girls increases as values of postmaterialism increases. Figure 9 shows the logit coefficients for boys expecting a career in STEM compared to girls. The figure illustrates that the probabilities are indeed increasing as postmaterialism increases, although the changes in effects are not big. The diagram shows the effects that gender has on expecting a career in STEM where socioeconomic and cultural status and science score is controlled for, for five different values of postmaterialism. The values of postmaterialism are shown in figure 9.

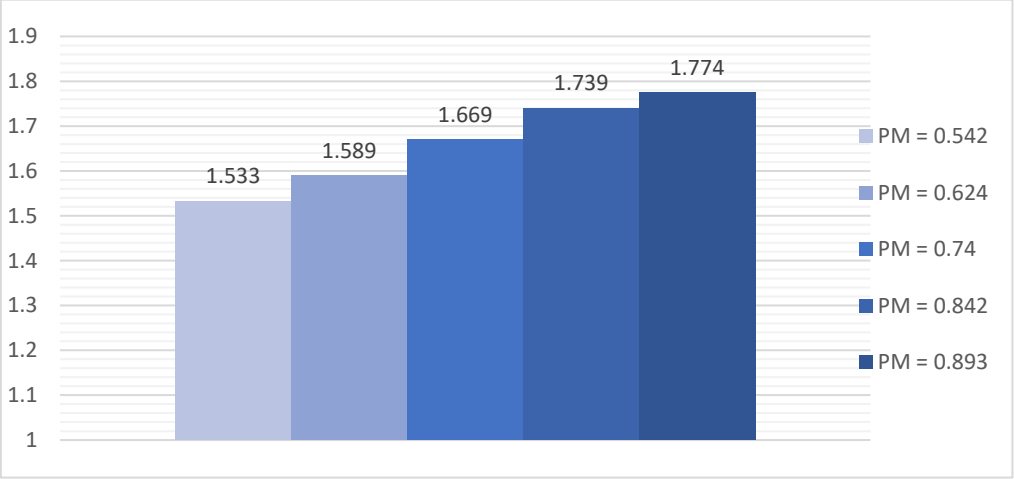

Figure 9.

The confirmation of hypothesis 1 thus show, that 15-year-old students' expectations toward their career at the age of 30 follows the tendency, where girls in more affluent and self-expressive countries to a lesser degree expects working in the field of STEM. This also provides motivation for elucidating the micro-causal mechanisms behind this correlation, which gender essentialist theory and expectancy-value theory seek to provide.

Hypothesis 1a, derived from the theory of gender essentialist theory and biased self-assessment, predicts that the boys will show a higher level of efficacy in science than girls, and that this relationship will increase as values of postmaterialism increases (Figure 3). Before conducting any multilevel analysis and determine whether postmaterialism moderates this direct effect as hypothesis 1a predicts, the intraclass correlation coefficient of science self-efficacy is calculated, as this will give an indication of whether science self-efficacy has variance on the between-level that can be explained with between-level predictors. The results of the intercept only model of science self-efficacy shows that a multilevel analysis is not warranted as the within-level variance is 1.498 and the between-level variance is 0.043. The ICC is thus 0.03 which will be considered too low to proceed conducting a multilevel analysis in which the country-level predictor postmaterialism could have explanatory power.

Having established that *Science self-efficacy* doesn't have variance on the between-level, it will be tested whether there exists a positive relationship between gender and self-efficacy in science. This relationship shows an estimate of 0.131 and it indeed appears to have a significant p-value. This holds when cultural and socioeconomic status and science score has been taken into account. Both of these covariates also have a positive significant effect on students' efficacy in science related subjects. What this shows is that there is indeed a positive relationship between gender and science self-efficacy even when actual science abilities are taken into account. This is furthermore the case cross-nationally where the effect of gender on science self-efficacy does not increase as values of postmaterialism increase which is what gender essentialist theory would predict. A biased self-assessment, where girls perceive their abilities in science to be lower than their actual abilities, and thereby underestimating their abilities, could be what is causing the relationship. Similarly, and in accordance with the theory of self-assessment bias, boys could also be more likely to overestimate their actual abilities, and that could cause the positive relationship between gender and science self-efficacy. However, given that the prediction derived from gender essentialism and self-assessment

bias, that this relationship would increase as values of postmaterialism increases, could also indicate that other factors are important when understanding the relationship.

Hypothesis 2a functions to test whether positive feedback in science from teachers will have a stronger positive effect on girls' science self-efficacy than it will for boys, and test whether this difference increases as values of postmaterialism increases. This entails a moderated moderation in which the student-level moderation is moderated by the between-level predictor postmaterialism. However, as already elucidated, science self-efficacy does not have variance on the between-level, which means that a multilevel analysis will not be conducted. A linear regression shows that *positive feedback* does appear to have a positive effect on the students' efficacy in science. This effect is furthermore moderated by gender, which the within-level part of hypothesis 2a predicts. The negative coefficient shows that the positive feedback from a teacher indeed affects girls' efficacy in science to a larger degree than it does for boys. This could indicate, as the theories of gender essentialism and self-assessment bias argue, that girls are more affected by positive feedback because they are inclined to believe that they are not as capable in science-related subjects as boys. Similarly, it could be showing that boys are not reacting as strongly toward positive feedback, because they are of the belief that they are naturally gifted in science-related subjects. Again, given that this relationship does not increase in effect when values of postmaterialism increases, the gender essentialist ideologies do not appear to increase in more post-materialistic societies. It is however possible, that the gender essentialist ideologies are present across all countries and that this is what causing the relationship.

Hypothesis 3a proposes a positive relationship between *science self-efficacy* and *expecting a STEM-field career*. As *expecting a STEM-career* has variance on the between-level, this hypothesis will employ a multilevel model. A fixed slope and random intercept model will function as an indicator for whether *science self-efficacy* and *expecting a STEM-career* is positively associated. Since the mechanism doesn't hypothesize the slopes to vary between countries the slopes will be held fixed. The random intercept model shows that increases in students' self-efficacy in science is positively associated with a higher probability of expecting a career in the STEM-fields.

As *science self-efficacy* does not have unexplained variance on the country-level, hypothesis 4a will not be conducted. This also means that the mechanism of gender essentialist theory and self-assessment bias is an inadequate mechanism when explaining the gender-gap increase in more affluent and post-materialistic countries. Figure 10 shows the predicted effects of the within-level relationships. The estimate of *science self-efficacy* on *expecting a STEM-career* is a logit coefficient

and should be interpreted as such, whereas the other within-level relationships are showing ordinal least squares coefficients.

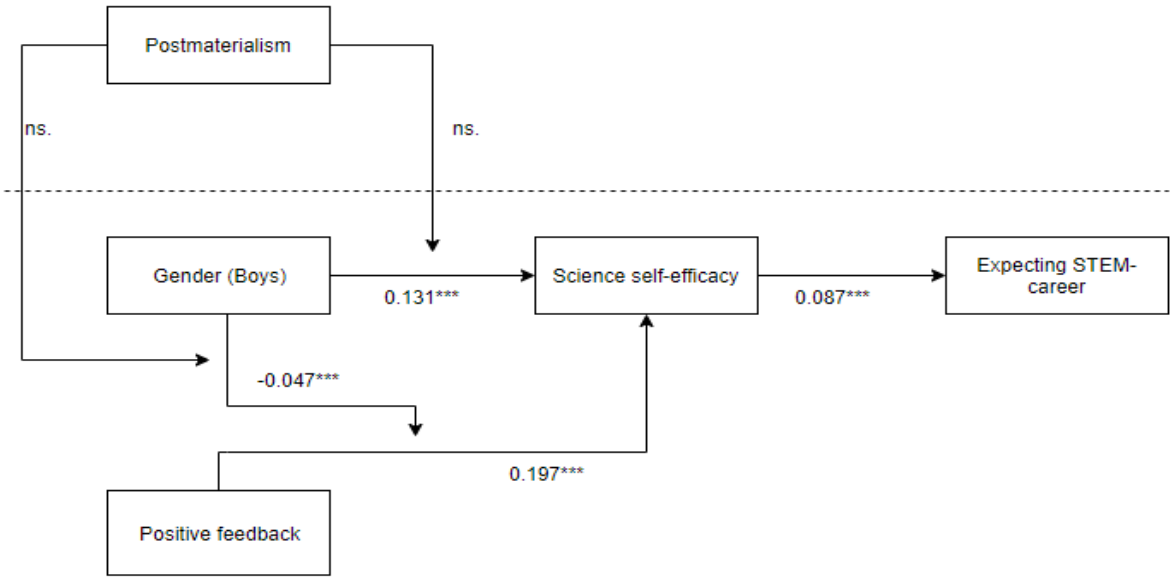

Figure 10.

When approaching hypothesis 1b, derived from the theory of expectancy value theory, the first step will be to determine whether the variable *reading as relative best* has country-level variation, which will determine whether a multilevel model is warranted. The ICC for *reading as relative best* is 0.12 which will be considered as too low to consider employing a multilevel model when assessing hypothesis 1b.

The regression analysis shows a negative coefficient of -0.210 for *gender* when regressed on the variable *reading as relative best*. The relationship is significant which leads to a confirmation of hypothesis 1b, that predicts that girls indeed more often have reading as their relative best subject.

Having established a negative relationship between *gender* and *reading as relative best*, the relationship between *reading as relative best* and *expecting a STEM career* and the expected cross-level interaction effect on this relationship is tested before approaching the moderated mediation analysis which hypothesis 2b expects. Having already established that the dependent variable *expecting a STEM-career* has variance on the country-level, an intercept only model will be skipped. The random intercept model is showing that the relationship between *reading as relative best* and *expecting a STEM-career* is indeed significant with a negative regression coefficient of -1.728. This

shows that if students have reading as their relative best subject, they are less likely to expect pursuing a STEM-career. The random slope model also indicate that the relationship has varying effects across countries.

The cross-level interaction model in which postmaterialism moderates the effect of having reading as a relative best subject and expecting a career in a STEM-field furthermore shows, that postmaterialism significantly moderates the within-level relationship. The negative logit coefficient of -3.016 shows, that as values of postmaterialism increases, students with reading as their relative best subject are less likely to pursue a STEM-career. These results yield information that strongly suggests running a moderated mediation analysis, in which it is hypothesized that the mediating variable *reading as relative best* is causing the association between *gender* and *expecting a STEM-career* to have a larger logit coefficient in more post-materialistic countries.

The cross-level moderated mediation analysis shows, that the mediating effect of *reading as relative best* in the 2-path analysis is indeed significant on postmaterialism. When testing hypothesis 1, figure 9 showed the total effects of the relationship between *gender* and *expecting a STEM-career* where socio- and cultural economic status and science score function as control variables. These were the total effects when *reading as relative best* wasn't taken into account. Figure 11 provides a graphical comparison of the direct effects that *gender* has on *expecting a career in STEM* and the total effects when *reading as relative best* mediates the relationship, for five values of the moderator *postmaterialism.* The total effects that were estimated in hypothesis 1 is subtracted by the indirect effects found in hypothesis 2b to calculate the direct effects.

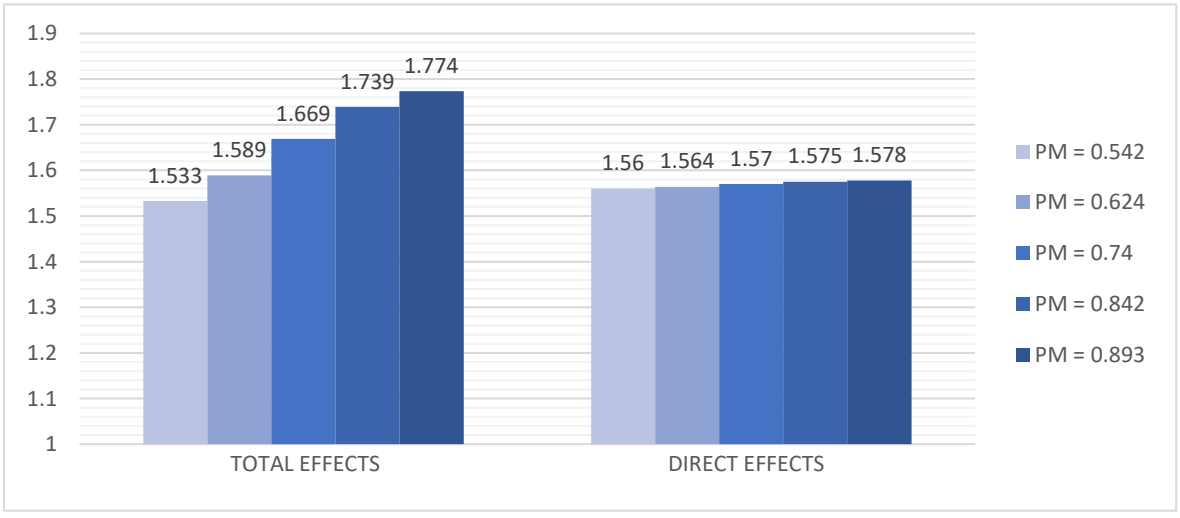

Figure 11

This result shows that *reading as relative best* mediates the relationship between *gender* and *expecting a STEM-career* as hypothesis 2b predicts. The hypothesis is thus confirmed, as the direct effects of the relationships are indeed close to being the same across countries when accounting for the effect of having reading as a relative best subject. Figure 12 shows the causal pathway, in which *b* indicate the indirect effect which should be seen relative to the total effects depicted in the bottom. Here, the indirect and total effects should be interpreted as logistic regression coefficients.

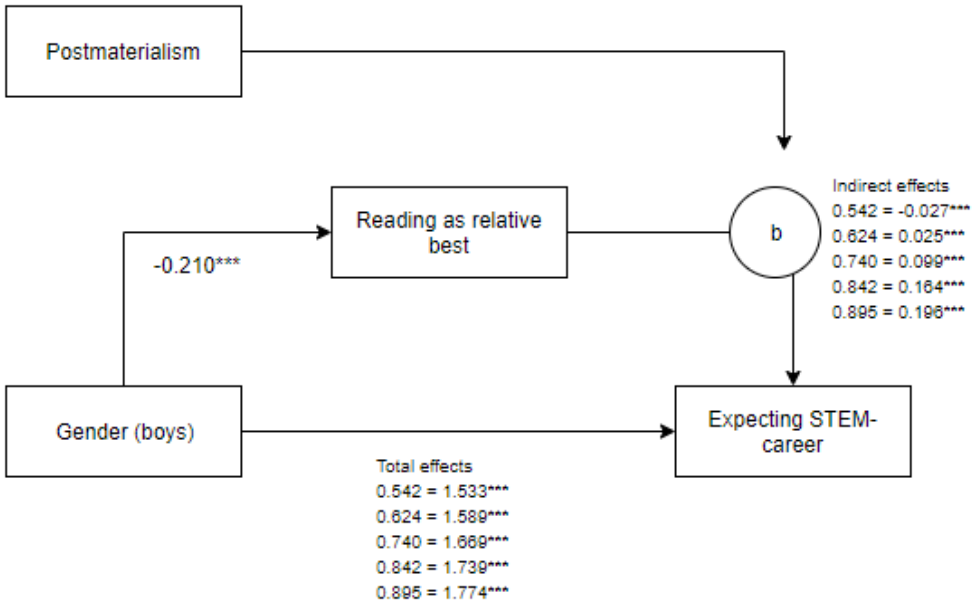

Figure 12.

Conclusion

The aim of this research was to examine whether the ratio of boys expecting a career in STEM in comparison to girls is increasing as levels of postmaterialism of countries increase. Furthermore, it has investigated two plausible mechanisms that could account for this relationship, namely gender essentialism accompanied by self-assessment bias and expectancy-value theory.

Hypothesis 1 was confirmed by a cross-level interaction model, in which the effects of gender increases as levels of postmaterialism increases. Although the increase in effects are not large, the significant cross-level interaction confirms that a statistically significant increase occurs as

postmaterialism increases. As the science scores and economic and cultural status has been accounted for, it also shows that these components are inadequate in explaining the increasing gender-gap.

Gender essentialism and self-assessment bias was used to test whether girls are showing lower levels of science self-efficacy than boys, when actual science abilities are controlled for. This was hypothesized to occur with an increasing effect as a country's level of postmaterialism increased, which would then lead to the larger gender-gap in more post-materialistic countries. This mechanism proved to be a weak explanation for the relationship found in hypothesis 1, as even though boys appear to show higher levels of efficacy in science, they do so cross-nationally, and the effect is not a consequence of an increase in post-materialistic values, which gender essentialism would predict. Although the theories of gender essentialism and self-assessment bias, which focuses on the role of the students' level of efficacy in science didn't prove to be an adequate explanation for larger gender segregation in more post-materialistic countries, it cannot be ruled out as an explanation for the gender segregation in STEM across countries, as some support has been found for a self-assessment bias occurring. Across all countries, girls are less likely than boys to expect a STEM-career when they are 30 years old. It is likely that the lack of efficacy in science-related subjects could have explanatory power when understanding the gender-gap in expecting a STEM-career that still exists across countries.

The hypotheses derived from expectancy-value theory were both confirmed in the analysis. Cross-nationally girls are indeed more likely to have reading as their relative best subject, which appears to influence the effect the relationship between gender and expecting a STEM-career, which becomes larger as postmaterialism increases. Figure 11 illustrates that the direct effects of gender on expecting a STEM-career is near the same across countries, when students who have reading as their relative best subject have been accounted for. This provides support for the argumentation that students in more post-materialistic countries seek to pursue a career in which they personally can excel and that this does not seem to be the case for students in less post-materialistic and affluent countries. However, the focus has been on the utility that students attach to pursuing an occupation, where the utility is considered intrinsic in post-materialistic societies and extrinsic in less post-materialistic societies. The confirmation of hypothesis 2b does provide some support for this, however it should be noted that the research hasn't provided evidence for that to be the case, as it hasn't been able to elucidate the subjective values the students attach to their future career-expectations. Future studies could advantageously seek to find empirical evidence for this mechanism either qualitatively or by

employing data that incorporate the subjective utilities that students attach to their future career-expectations.

Discussion

This research sat out to investigate the expectations of 15-year-old students in working in a STEM-related field. This aim was derived from the finding that actual graduation rates show that more affluent and developed societies has fewer women graduating in STEM-related fields. This study shows that this paradoxical finding is also apparent in the expectations of 15-year-old students, although it may not be as pronounced as actual graduation rates. As this study uses the expected career choices of students, the results also ought to be interpreted with caution as it is very likely that expectations of career choices are influenced by other factors after primary school. However, it does provide some evidence for the fact, that the rates that the actual graduations show can be a consequence of expectations made early in the students' educational career. The results of the study show that the increased gender-segregation in more affluent and post-materialistic countries in STEM-field occupations can be explained, when using the expected career choices of 15-year-old students as the measure of interest. The mechanism derived from the expectancy-value theory therefore ought to be taken into consideration when trying to explain the lack of women graduating in the STEM-fields in affluent and wealthy societies.

The finding of the relationship between the gender equality gap index and actual graduation rates in STEM-fields has been the primary force driving this research. The paradox of having fewer women graduating in STEM in more gender-equal countries indeed seems puzzling, as the gender-equality gap index is among other things measured by equal educational opportunities between men and women. However, as Stoet & Geary also note, the countries that achieve high scores in gender equality also tend to be more affluent societies, and some with strong welfare states (Stoet & Geary 2017). This research has sought to explain the relationship by focusing on an increase in affluency and thereby possible self-expressive values in these societies. As this research provides a micro-level explanation for the observed macro-level phenomenon it should be considered whether the relationship ought to be considered paradoxical at all. The findings of the present study support the line of argumentation in which students in more affluent societies simply follow career paths where they believe they can excel. As girls more often than boys have reading as their best subject in terms of achievement, the larger gender-segregation will, according to the theoretical considerations

provided by expectancy-value theory and theories of postmaterialism occur in affluent societies. The present study suggests that the utility that students in less affluent countries ascribe to pursuing a certain educational path is extrinsic rather than an intrinsic self-fulfillment utility. The results support to some extent this hypothesis, as girls in less affluent or post-materialistic societies, to a larger extent are interested in pursuing a STEM-field career, regardless of having other subjects in which they personally excel. As STEM-field occupations are considered to be some of the most well-paid jobs, this would make sense from a perspective of expectancy-value theory, where the utility can be considered as extrinsically gained.

Multiple psychological studies have examined sex differences in terms of personality traits on "the big five" and vocational interests (Falk & hermle 2019; Lippa 2010; Su et al. 2009). The studies provide evidence of existing sex differences in personality traits between men and women, although these differences are small and can be mostly ascribed to differences on the two components of neuroticism and agreeableness (Lippa 2010). Furthermore, these differences are found to be larger in more gender-equal and economically developed societies (Falk & Hermle 2019; Lippa 2010). However, the differences in vocational interests are found to be large and consistent across cultures. The differences found to be largest are in the Realistic and Social vocational interests, that is typically conceptualized as the things-people dimension (Lippa 2010; Su et al. 2009). These differences in vocational interests are found to be formed very early in the subjects lives and furthermore tends to be stable across ages, although the cross-sectional design limits the explanatory power of assessing the stability of vocational interests across time (Su et al. 2009). It does however show a difference between boys and girls when it comes to interests in the things-people dimension, which cannot be ruled out as having explanatory power for the gender gap in STEM-field expectations and graduations. This could be an explanation for why girls tend to score higher in reading-related subjects in the first place, as girls on average are interested in different subjects than boys. It is also likely that a mechanism following the same line of argumentation as the present study has explanatory power, in which post-materialistic societies promote students to choose occupational careers in which they are most interested, as extrinsic gains are considered less significant. Similarly, although girls in less post-materialistic societies may have interests other than engineering and technology, it may be an economically advantageous career-choice to pursue a STEM-career. Whether the vocational interest differences can be ascribed to social-environmental or biological theories is not simple to conclude, however it can be argued as Lippa does, that the consistency of sex-differences in vocational interests across cultures could indicate possible biological explanations (Lippa 2010).

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Appendix A

ISCO-codes	STEM-Fields
2100	Science and engineering professionals
2110	Physical and earth science professionals
2111	Physicists and astronomers
2113	Chemists
2114	Geologists and geophysicists
2120	Mathematicians, actuaries and statisticians
2130	Life science professionals
2140	Engineering professionals
2141	Industrial and production engineers
2142	Civil engineers
2143	Environmental engineers
2144	Mechanical engineers
2145	Chemical engineers
2146	Mining engineers
2149	Engineering professionals
2150	Electrotechnology engineers
2151	Electrical engineers
2152	Electronics engineers
2153	Telecommunications engineers
2262	Pharmacists
2500	Information and communications technology professionals
2510	Software and applications developers and analysts
2512	Software developers
2513	Web and multimedia developers
2514	Applications programmers
2519	Software and applications developers
2522	Systems administrators
2523	Computer network professionals
2529	Database and network professionals
3100	Science and engineering associate professionals
3110	Science and engineering associate professionals
3111	Chemical and physical science technicians
3112	Civil engineering technicians
3113	Electricals engineering technicians
3114	Electronics engineering technicians
3115	Mechanical engineering technicians
3116	Chemical engineering technicians
3119	Physical and engineering science technicians not elsewhere classified
3140	Life science technicians and related associate professionals

ISCO-codes	STEM-Fields
3141	Life science technicians (excluding medical)
3211	Medical imaging and therapeutic equipment technicians
3212	Medical and pathology laboratory technicians
3213	Pharmaceutical technicians and assistants
3214	Medical and dental prosthetic technicians
3254	Dispensing opticians
3255	Physiotherapy technicians and assistants
3314	Statistical mathematical and related associate professionals
3500	ICT technicians
3510	ICT operations and user support technicians
3511	ICT technology operations technicians
3512	ICT user support technicians
3513	Computer network and systems technicians
3514	Web technicians

Appendix B

Inequality-adjusted HDI	Country
0.893	Norway
0.861	Netherlands
0.861	Switzerland
0.858	Australia
0.856	Denmark
0.853	Germany
0.846	Sweden
0.846	Iceland
0.836	Ireland
0.834	Finland
0.832	Canada
0.829	Slovenia
0.829	United Kingdom
0.823	Czech Republic
0.822	Luxembourg
0.820	Belgium
0.816	Austria
0.811	France
0.791	Slovak Republic
0.782	Estonia
0.780	Japan
0.775	Spain

Inequality-adjusted HDI	Country
0.775	Israel
0.773	Italy
0.769	Hungary
0.767	Malta
0.760	United States
0.760	Poland
0.758	Greece
0.754	Lithuania
0.751	Korea
0.744	Portugal
0.743	Croatia
0.730	Latvia
0.728	Montenegro
0.714	Russian Federation
0.711	Romania
0.699	Bulgaria
0.678	Uruguay
0.672	Chile
0.652	Georgia
0.641	Turkey
0.625	Jordan
0.618	Moldova
0.609	Lebanon
0.587	Mexico
0.576	Thailand
0.563	Peru
0.562	Tunisia
0.559	Indonesia
0.557	Brazil
0.549	Vietnam
0.546	Dominican Republic
0.542	Columbia