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Exploring Serial Mediation Effects of Gender Roles and Motivation on Gendered Educational Choice

Abstract

The aim of our study, grounded in the situated expectancy-value theory (SEVT), was to examine the mediating role of gender roles and motivational beliefs in physics on the relationship between gender and the intention to choose a university course in technical sciences. A total of 625 secondary school students from Zagreb, Croatia, participated in the study. Gender Roles in Adolescence Scale contained Femininity and Masculinity scales, and Motivational beliefs in physics were measured by Expectancy of success and Utility value scales. Our findings show that the relationship between gender and the intention to choose a technical sciences course is serially mediated by gender roles and motivational beliefs. Young men were more likely to choose a technical sciences course than young women. This was explained by young men's higher masculinity and lower femininity scores (compared to young women), which led to their higher expectancy of success and utility value in physics, finally resulting in young men's stronger intention to choose a technical sciences course. Encompassing a novel statistical approach, this is the first study to empirically support these complex serial relations explaining gender differences in educational choices within SEVT. Policy implications of our findings point to the necessity of challenging traditional gender roles in educational systems and raising awareness of their impact on the gender division in higher education courses and occupations.

Keywords: gender, gender roles, motivation, situated expectancy-value theory, serial mediation

1. INTRODUCTION

In different countries, women are underrepresented in university courses and careers in technical sciences (TS) (Australian Government Department of Industry, Science and Resources, 2023; Corbet & Hill, 2015; Croatian Bureau of Statistics, 2023; European Institute for Gender Equality, 2023). Our research is an attempt to contribute to the understanding of the gender gap in technical sciences, from the educational psychology perspective within the framework of situated expectancy-value theory (SEVT) (Eccles et al., 1983; Eccles & Wigfield, 2020). We have focused on TS, given that TS are one of the most male dominated scientific domains, compared to other STEM domains (e.g. life sciences) (Australian Government Department of Industry, Science and Resources, 2023; Croatian Bureau of Statistics, 2023; European Institute for Gender Equality, 2023). In this paper we aimed to explore the mediating effects of gender roles and motivational beliefs on gender differences in the intention to choose a TS university course among secondary school students in Croatia. Notably, this study is the first to empirically test these serial mediation effects underlying gender differences in educational choices within the widely used SEVT. In the following sections theoretical background for the study is outlined, together with an overview of empirical studies on relations between gendered educational choices, gender roles and motivation.

1.1 Theoretical Overview

Different theoretical and empirical approaches have so far provided various explanations for the gender gap in TS and similar educational choices, including a lack of role models for gender atypical choices, negative impact of gender stereotypes on educational choices, gender differences in motivation, traditional gender role attitudes, and conforming to gendered societal expectations about career interest and choices (Eagly et al., 2000; Eccles & Wigfield, 2020; Steele, 1997). The most comprehensive explanation of gendered educational choices comes from the Eccles et al. situated expectancy-value theory (SEVT) (Eccles et al., 1983; Eccles & Wigfield, 2020) that considers the importance of students' motivational beliefs, gender roles, and gender stereotypes, as well as role models' beliefs and a wider social context, in shaping educational choices.

The key hypothesis of this theory is that gender differences in educational choices result from gender differences in motivational beliefs, more specifically in expectancy of success and task values. Furthermore, it was hypothesized that motivational beliefs are shaped by gender roles and stereotypes, as well as by socialization influences, previous achievement and experiences, and a wider cultural context (Eccles & Wigfield, 2020). In this study, our interest is focused on expectancy of success, task values, and gender roles.

Expectancies of success are individual beliefs in how successful one will be at a certain activity in the future, e.g., in writing an exam or enrolling into a university course (Eccles & Wigfield, 2020). The self-concept of one's ability is a similar construct, but it encapsulates broader beliefs about one's competence, such as evaluation of a persons' ability in mathematics or physics. According to the SEVT, subjective task values, i.e. the values that an individual attaches to a task or activity, include utility value, intrinsic value, attainment value, and cost. The utility value refers to the perceived usefulness of the task in achieving short- or long-term goals. For example, learning physics has a higher utility value if it is useful for enrolling in a desired university course. The intrinsic value or interest refers to the anticipated enjoyment in performing a task or choosing an activity. The attainment value is defined as personal importance of performing well at the task, whereas the perceived cost encompasses negative aspects of engaging in a task, like the effort required to succeed in a task or fear of failure at the task (Eccles & Wigfield, 2020). Gender roles refer to the shared cultural expectations about appropriate gender-related behaviors (Spence & Helmreich, 1978), and are manifested in the psychological characteristics of femininity and masculinity (Bem, 1974; Deaux & Lafrance, 1998). Femininity is often operationalized through the possession of expressive traits such as compassion, sensitivity and cheerfulness, and masculinity through the possession of instrumental traits such as leadership and independence (Holt & Ellis, 1998; Spence & Helmreich, 1978).

1.2 Empirical Overview

The focus of this review of empirical studies within SEVT is on the structural relations between gender, gender roles, motivation and educational choice, with a special interest in mediations. We were particularly interested in the motivation for physics and the choice of TS, given the most pronounced gender imbalance in favor of boys and men in these domains, compared to e.g., motivation for mathematics and the choice of STEM in general (Croatian Bureau of Statistics, 2023; Keller et al., 2022; Marušić, 2006). However, due to a lack of these studies, we reported on the studies about the relations of gender, gender roles, motivation and educational choice in other domains.

The empirical studies within SEVT have largely been focused on the role of different motivational beliefs in the explanation of educational choices, showing that both expectancy of success and task values are important in predicting educational choices (e.g., Fong et al., 2021; Lauermann et al., 2017). The mediating role of motivation on the relation between gender and educational choice has so far been explored in different educational fields (e.g., Eccles & Wang, 2016; Nagy et al., 2006; Tellhed et al., 2018). For example, in a study that examined whether a domain-specific academic self-concept and intrinsic value mediated the effects of gender on choosing mathematics or biology courses in upper secondary education in Germany, it was shown that gendered course choices were indeed mediated by the self-concept, intrinsic value, and previous achievement (Nagy et al., 2006). The mediating role of competence beliefs and career goals in the explanation of gender differences in educational choices of male-dominated (technology), female-dominated (social sciences, humanities, arts) or gender balanced high school program was tested with the sample of Swedish adolescents (Tellhed et al., 2018). The results supported SEVT's hypothesis and revealed that gender differences in educational choices can be understood in terms of differences in competence beliefs and career goals. In addition, a longitudinal study conducted in the United States showed that gender differences in 12th grade math ability beliefs and in valuing a people-oriented versus thing-oriented career, mediated the effect of gender on career choice in STEM disciplines (mathematics, health, biological, medical, physical, computer, and engineering sciences), ten years later (Eccles & Wang, 2016). In other words, men were more likely to pursue STEM careers, due to their previous higher math ability self-concepts and a greater tendency to work with things than to work with people, compared to

women. Finally, a study on Swiss secondary school students showed an indirect effect of gender on career choice in technology and engineering through the self-concept for science-based technology (Smit et al., 2020). Girls were less likely to choose technology and engineering due to their lower self-concept for science-based technology.

Within the SEVT, gender roles have been explored to a lesser extent than motivational beliefs. According to the theory, higher level of masculinity and/or lower level of femininity predict the choice of a typically male educational choice (e.g., mathematics or TS courses) (Eccles, 1987). Contributions of gender roles were studied more than 20 years ago on samples of secondary school students in the United States. However, it was shown that the effects of gender roles on achievement, effort or persistence in mathematics or science were either small or statistically nonsignificant (e.g., Debacker & Nelson, 1999; Greene et al., 1999). There are only a few studies including gender roles and educational choices across various educational fields investigating the mediation effects (e.g., Guillet et al., 2006; Tokar & Jome, 1998; Wegemer & Eccles, 2019). For example, a study on male undergraduate and graduate students in the United States explored if vocational interests mediated the relation between masculinity and career choice traditionality (i.e., the choice of careers in which men are predominant) (Tokar & Jome, 1998). It was shown that more masculine young men were indeed more likely to choose male dominated careers, and that this effect was fully mediated by vocational interests. A study with adolescent girls in France showed that endorsing a more traditional feminine gender role (higher femininity, lower masculinity) predicted the choice of dropping out of playing handball (perceived as a masculine sport), and that this effect was fully mediated by motivational variables: perceived competence in handball and the perceived value of handball (Guillet et al., 2006). Additionally, a study conducted at a public university in the United States examined whether the effects of masculinity and femininity on choosing a STEM major (e.g., biological sciences, chemical engineering, computer science, electrical engineering, mathematics, physics) were mediated by occupational values such as "communitarian/altruistic," "independence," and "stability" (Simon et al., 2016). Higher femininity scores predicted lower odds of majoring in a STEM field for female students, however this effect was not mediated by occupational values. The mediating effect of occupational values was observed only among male students: higher femininity scores were linked to stronger communitarian/altruistic occupational values, which in turn, were associated with lower odds of pursuing a STEM major. Contrary to expectations, higher masculinity scores

were not linked to increased odds of majoring in a STEM field; instead, they were surprisingly associated with lower odds of choosing a STEM major, but only for male students. And finally, a cross-sectional study conducted in the United States on six sub-samples of participants aged from 13 (7th grade) to 26 explored the relationships between gender, femininity, altruism, math self-concept of ability, and math task value, and STEM choices (Wegemer & Eccles, 2019). The results showed that regardless of being male or female, giving a greater importance to femininity predicted higher probability of choosing health, biological, and medical sciences over mathematical, physical, engineering, and computer sciences. In addition, the relationship between femininity and choosing mathematical/engineering related courses over health related courses was mediated by occupational altruistic values (in a negative direction) and math self-concept of ability (in a positive direction), but not by math task values (Wegemer & Eccles, 2019). The authors have concluded that students possibly chose health, biological, and medical sciences over mathematical, physical, engineering, and computer sciences, because they presume that these careers would allow them to be more feminine.

1.3 The Present Study

Empirical review has showed that gendered course choices were mediated by different motivational beliefs: self-concept, intrinsic value, valuing a people-oriented versus thing-oriented career, and career goals (Eccles & Wang, 2016; Nagy et al., 2006; Smit et al., 2020; Tellhed et al., 2018). However, there is scarce empirical evidence on the mediating role of gender roles in the relationship between gender and educational choices. In addition, as to our knowledge, still no empirical research simultaneously tested gender roles and motivational beliefs as mediators of the relationship between gender and educational choice within SEVT. Given that SEVT implicates serial mediation involving these variables (Eccles & Wigfield, 2020), we wanted to test these complex relationships in our research. This study is the first to use this novel approach and examine whether these relations proposed in theory are supported in the data. Additionally, this is one of the rare studies examining the mediating role of gender roles within SEVT, especially in contemporary context. Moreover, the study is contextualized within technical sciences, contributing to the understanding of the gender gap in a specific scientific

field where women are particularly underrepresented (Croatian Bureau of Statistics, 2023; European Institute for Gender Equality, 2023). In addition, we have chosen to focus on motivation for physics given that the gender gap in physics exceeds the one in mathematics and natural sciences in general, and that physics is a "gateway" subject to many technical sciences courses (Keller et al., 2022; Marušić, 2006). Therefore, our approach offers a fresh perspective and a shift from exploring the role of mathematics or science motivation.

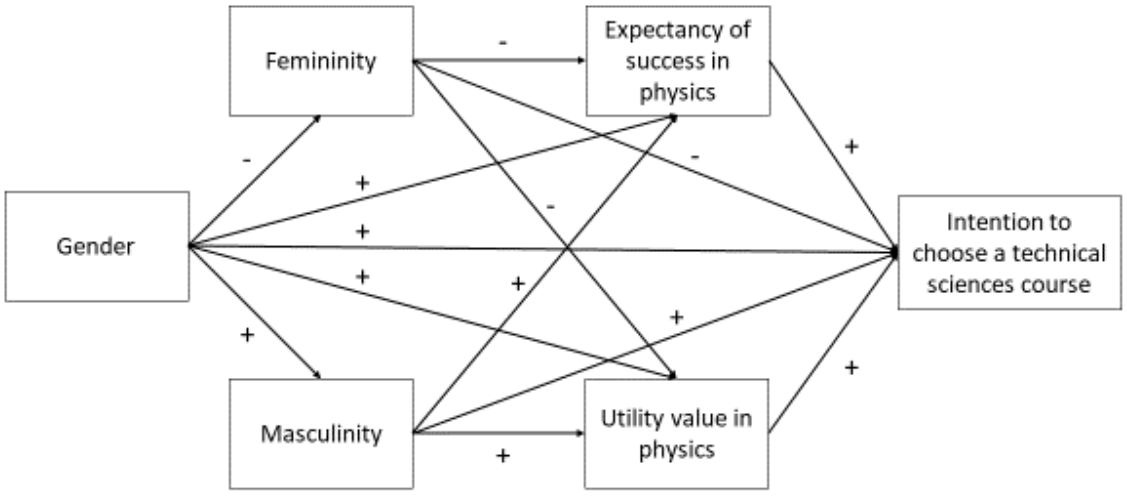
The aim of the present study was to examine the role of gender roles and motivational beliefs in physics in a relationship between gender and the intention to choose a technical sciences course.[*] Based on the SEVT (Eccles & Wigfield, 2020) and previous research, we expected that young men would be more likely to choose a TS course than young women (H1). We also expected that the relationship between gender and the intention to choose a TS course would be mediated by gender roles (masculinity and femininity) (H2). In addition, we expected that the relationship between gender and the intention to choose a TS course would be mediated by motivational beliefs (expectancy of success and utility value of physics) (H3). Finally, we expected that the relationship between gender and the intention to choose a TS course choice would be serially mediated by gender roles and motivational beliefs (H4).

Hypothesized mediation model and direction of expected relations are depicted in Figure 1.

[*] In order to keep the model simple and to avoid multicollinearity, which is expected when many motivational beliefs are simultaneously explored, two motivational beliefs were chosen for our analyses: expectancy of success and utility value.

Figure 1.

Hypothesized Mediation Model and Relations between Variables



Note. Gender: 1-Female, 2-Male.

2. METHOD

2.1 Participants and Procedure

A total of 625 secondary school students from Zagreb, Croatia, participated in a study (58.7% of young women, 41.3% of young men). The students were enrolled in the third grade of general grammar schools and were on average 17 years old.

The study was carried out as part of a larger research on the role of gender roles, gender stereotypes and motivation in students' gendered educational choices and achievement. An invitation to participate in the research was sent to the chosen general grammar schools in Zagreb. General grammar schools were chosen because in this type of school the educational and

career interests of students are the most diverse. Additionally, the students presumably did not limit their interests to a specific educational field upon enrolment (unlike the students in natural sciences and mathematics grammar schools, foreign language grammar schools, or vocational schools). The questionnaire was administered in schools during one school hour (45 min).

2.2 Protection of Vulnerable Populations

The research was conducted in accordance with the Code of Ethics for Research with Children (Ajduković & Kolesarić, 2003) and approved by the relevant ministry of education, as well as by the schools that participated in the study. We ensured that participation in the research was voluntary and confidential. Students were informed about the study aims, procedure and their rights, after which they decided if they wanted to participate by giving their informed consent. Students were informed that they can withdraw from participation at any time without any consequences, and that they are free to skip any questions they are not comfortable with answering. It was also explained that neither their teachers, nor other members of the school staff would have access to their data. Following the ethical guidance for research with children, we ensured that participants did not experience any risk beyond that of everyday life.

At the end of data collection, time was left for a conversation with the participants. They had the opportunity to ask additional questions about the research itself and to discuss various options for their desired career choices. The researcher provided them with several possible information resources for career guidance that are available to them as secondary school students, including resources about gender non-stereotypical career choices. This practice could be encouraging for students with non-traditional career aspirations, including young women who aspire to TS careers. Moreover, as a female in a predominantly male occupation (science), the researcher herself was a non-stereotypical professional role model, which could have been encouraging for young women. Students were also given the researcher's e-mail address as an opportunity to ask additional questions confidentially. The data were analyzed and presented only at the group level, and individual results were visible only to the research group to ensure confidentiality of participants' data.

2.3 Authors Positionalities

Both authors are White women coming from and working in Croatia. The first author is a Senior Scientist, with a Ph.D. in psychology. Her research interests include psychology of education and psychology of gender, with an emphasis on topics such as the gender dimension of education and the wellbeing of students and teachers. She is the main researcher of the project, participating in all research activities, which includes the collection, preparation, analysis and interpretation of the data, and the writing and reviewing of this paper. The second author is a research assistant, enrolled in a Ph.D. program in psychology. Her research interests include the fields of educational psychology, gender psychology, motivation, individual differences and advanced statistics. She conducted the main analysis, interpreted the results, and participated in all stages of the writing and reviewing of this paper.

Both authors could identify with participants, being female researchers in a predominantly masculine occupation (science), and with a theoretical background and research experience in the field of gender underrepresentation in education. However, neither of us has a higher educational background in TS. Writing this paper, we discussed our positionalities toward the interpretation of the data and conclusions of the paper.

2.4 Instruments

Gender roles were measured by the Gender Roles in Adolescence Scale (Author, 2008, 2017). The instrument contains two subscales: Femininity scale (n=16; sample item: 'I am very sensitive.'), and Masculinity scale (n=16; sample item: 'I like to watch sports competitions'). Both scales consist of items about adolescents' behaviors, traits and interests across various aspects of their lives including family, school, leisure, appearance and intimate relationships that are either socially more expected from adolescent girls or adolescent boys. Participants were asked how typical for them is each of the behaviors and traits on a 5-point Likert scale ranging from 1 (not at all) to 5 (completely). Reliability was high ($\alpha_{Feminity}$=.86; $\alpha_{Masculinity}$=.80). Higher scores indicated being more feminine/masculine.

Motivational beliefs in physics were measured by two scales (Author, 2017; adapted to the Croatian context from Eccles & Wigfield, 1995). *Expectancy of success in physics* was measured by 3 items (sample item: 'How successful do you think you would be at a university course in which physics knowledge was important?'), and participants responded on a five-point bipolar scale ranging from 1 (completely unsuccessful) to 5 (completely successful). *Utility value of physics* was also measured by 3 items (sample item: 'To what extent will what you learn in physics be useful for enrolling in the university course of your choice?'). Responses were positioned on a five-point bipolar scale from 1 (not at all) to 5 (completely). Reliability was high ($\alpha_{Expectancy}$=.90; $\alpha_{Utility}$=.94).

Intention to choose a technical sciences university course was measured with one item. Participants were asked, 'How likely is it that you are going to try to enroll into the technical sciences courses, e.g., electrical engineering, computer science, mechanical engineering, naval architecture or civil engineering?"[†]. Participants could respond on a 5-point Likert type scale ranging from 1 (extremely unlikely) to 5 (extremely likely).

2.5 Data Analysis

To test the expected mediation model, we used PROCESS macro for SPSS IBM by Hayes (2022). Since Hayes' (2022) book does not include a model with the relations that we expected, we constructed a combination of a parallel and serial mediation model using Process Syntax. Our model (Figure 1) is similar to Hayes' (2022) Model 82 with added effects of gender roles on expectancy of success and utility value, in accordance with SEVT (Eccles et al., 1983; Eccles & Wigfield, 2020).

As an inferential test for indirect effects, we used 95% bootstrap confidence intervals (CI) on 5,000 random samples. Bootstrap confidence intervals respect non-normality of the sampling distribution of indirect effects (products of regression coefficients), which makes it more

[†] These are only the most typical examples and not an exhaustive list of the TS course types in Croatia (some other courses include metallurgy, mining geology and petroleum engineering, geodesy, architecture, etc.)

appropriate than the Sobel test (Hayes, 2022). If confidence interval does not include zero, we can assume that the indirect effect is statistically significant.

3. RESULTS

3.1 General Descriptive Statistics

The results of t-test revealed that young men were more likely to choose a TS course than young women (t = -11.32, df = 479, p < .001).‡ Pearson's correlation coefficients between measured variables are displayed in Table 1. All tested variables have significant relations, which is one of the postulates for testing mediation effects. Correlations are small to moderate, and all are positive, except the relations with femininity, which are in the opposite direction. Men, students who are less feminine, more masculine, have higher expectancy of success and higher utility value of physics; are more likely to choose a TS course.

Table 1.

Pearson Correlation Matrix (N = 625)

Variable	2.	3.	4.	5.	6.
1. Gender	-.74**	.52**	.30**	.29**	.43**
2. Femininity	1	-.21**	-.25**	-.26**	-.33**
3. Masculinity		1	.26**	.24**	.37**
4. Expectancy of success			1	.67**	.53**
5. Utility value				1	.59**
6. Intention to choose a technical sciences course					1

Note. ** p < .01. Gender: 1- female, 2-male

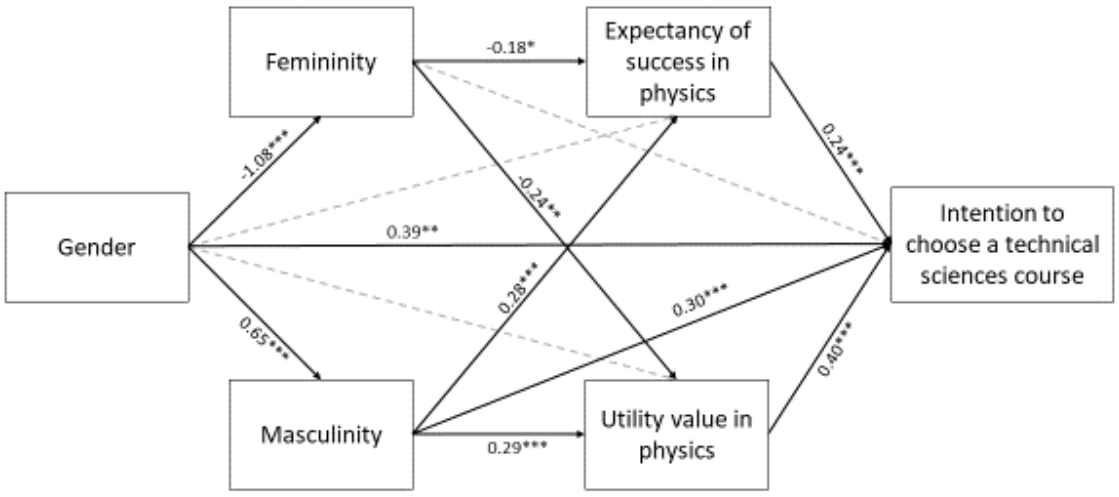
‡ Results from the same research project published in the paper by Author (2017) revealed that young women had higher scores on femininity, lower on masculinity, and that they also had lower expectancy of success and utility value of physics compared to young men.

3.2 Mediation Model Analysis

Unstandardized regression coefficients of the tested mediation model are shown in Figure 2. Most of the tested paths were significant and in the expected direction. For example, young women had higher femininity scores, lower masculinity scores and a lower intention to choose a TS course. Students with more feminine traits had lower expectancy of success in physics and lower utility value in physics. On the other hand, students with more masculine traits had higher expectancy of success, higher utility value in physics and a greater intention to choose a TS course. Students with higher expectancy of success in physics and higher utility value in physics also had a greater intention to choose a TS course. However, effects of gender on motivational beliefs (expectancy of success and utility value), as well as the effect of femininity on the intention to choose a TS course were not significant. Additional statistical information about regression coefficients is provided in Appendix A. Baron and Kenny (1986) used to theorize that all regression coefficients should be statistically significant to even be able to test indirect effects. However, in contemporary statistical literature (Hayes, 2022) this is not a precondition for mediation analysis. Since mediation effects are defined as products of regression coefficients in its background (ind=*ab*), Hayes (2022) emphasizes it is only important to test if these products are statistically significant. Hence, we continued with mediation analysis.

Figure 2.

Unstandardized Regression Coefficients of the Tested Mediation Model (N = 625)



Note. * $p < .05$. ** $p < .01$. *** $p < .001$. Gender: 1-Female, 2-Male.

Within this model, we tested four simple indirect effects and four serial indirect effects of gender on the intention to choose a TS course. Indirect effect sizes and confidence intervals are presented in Table 2.

The only significant simple indirect effect was the effect of gender on the intention to choose a TS course through masculinity. Young men had a higher masculinity score than young women, and higher masculinity led to higher probability to choose a TS course. On the other hand, all four serial indirect effects were statistically significant. Young men had lower scores on femininity, which led to higher expectancy of success in physics, which in turn led to higher probability of choosing a TS course. Similarly, young men had lower scores on femininity, which led to higher utility value of physics, which in turn led to higher probability to choose a TS course. These paths are similar to the ones that have masculinity as the first mediator, but in the opposite direction. More specifically, young men had higher masculinity, which led to higher

expectancy of success, which then led to higher probability of choosing a TS course. In addition, young men were more masculine, which led to greater utility value, which led to a greater intention to choose a TS course.

Table 2.

Unstandardized Indirect Effects of Gender on the Intention to Choose a Technical Sciences Course; Effect Size, Standard Error and Upper and Lower Levels of 95% Confidence Intervals

	X	M	Y	Effect	SE	LLCI	ULCI
Ind1[a]	Gender	→Femininity→	Intention to choose a technical sciences course	0.081	0.089	-0.094	0.258
Ind2	Gender	→Masculinity→	Intention to choose a technical sciences course	0.195	0.054	0.088	0.304
Ind3 [a]	Gender	→Expectancy of success→	Intention to choose a technical sciences course	0.053	0.035	-0.013	0.125
Ind4 [a]	Gender	→Utility value→	Intention to choose a technical sciences course	0.091	0.064	-0.031	0.221
Ind5	Gender	→Femininity→ →Expectancy of success→	Intention to choose a technical sciences course	0.047	0.025	0.002	0.101
Ind6	Gender	→Femininity→ →Utility value→	Intention to choose a technical sciences course	0.104	0.043	0.021	0.190
Ind7	Gender	→Masculinity→ →Expectancy of success→	Intention to choose a technical sciences course	0.044	0.017	0.016	0.083
Ind8	Gender	→Masculinity→ →Utility value→	Intention to choose a technical sciences course	0.075	0.025	0.030	0.127

Note. [a] Rows presenting nonsignificant indirect effects (Ind1, Ind3 and Ind4).

We used contrasts to test if there were differences in the size of significant indirect effects. The contrasts showed that indirect effect of gender on the intention of choosing a TS course through

masculinity was significantly greater than serial indirect effect through femininity and expectancy of success (C = 0.148, SE = 0.061, CI: [0.026-0.268]) and serial indirect effect through masculinity and expectancy of success (C = 0.151, SE = 0.058, CI: [0.038-0.263]). Other indirect effects did not significantly differ in size.

This model explained 18.09% of variance of the intention to choose a TS course with a significant total effect of 1.084 (SE = 0.092). Direct effect size of gender on the intention of a TS course choice, as can be seen in Figure 2, was 0.394, while total indirect effect was 0.689 (CI: [0.434-0.931]).

4. DISCUSSION

This study examined the relations between gender, gender roles, motivational beliefs for physics, and the intention to choose a technical sciences university course on a sample of secondary school students in Croatia. Our results revealed theoretically meaningful relations between the studied variables previously unexplored within the SEVT framework (Eccles & Wigfield, 2020).

Overall, our findings offered a strong empirical support for the hypothesized relations. Our first hypothesis, that young men would be more likely to choose a TS course than young women, was confirmed. These findings are in line with numerous empirical studies and statistical data across Europe, the United States, Australia etc. (e.g. Australian Government Department of Industry, Science and Resources, 2023; European Institute for Gender Equality, 2023; National Center for Science and Engineering Statistics, 2023; World Economic Forum, 2023). Our second hypothesis predicted that the relationship between gender and the intention to choose a TS course would be mediated by gender roles (masculinity and femininity). This hypothesis was partially confirmed. It was confirmed for the simple indirect effect of gender on the intention to choose a TS course through masculinity. The directions of these relations were also expected: young men had a higher masculinity score than young women, and higher masculinity led to higher probability to choose a TS course. However, femininity was not shown to be a mediator of the relationship between gender and the intention to choose a TS course. In other words, men were more likely to choose a TS course due to their higher masculinity, whereas femininity did not

add up to this relationship between gender and a TS course choice. These findings contribute to the conceptualization of gender dimension of the SEVT, given that studies on the mediation role of gender roles in the effect of gender on educational choices within SEVT are missing, and that the results of the existing studies on the effect of gender roles on educational outcomes are mixed or show a weak effect (e.g. Debacker & Nelson, 1999; Green et al., 1999). Our third hypothesis, that the relationship between gender and the intention to choose a TS course would be mediated by motivational beliefs was not confirmed, given that simple indirect effects of gender on the intention to choose a TS course through expectancy of success or utility value of physics were statistically nonsignificant. Although this specific mediation is not depicted in the SEVT (e.g. Eccles et al., 1983; Eccles & Wigfield, 2020), it was implied in texts (e.g., Eccles, 1987), and several empirical studies have evidenced the mediation role of motivational beliefs in the relationship between gender and educational choice. For example, gender differences in subject choices were mediated by motivational beliefs such as self-concept, intrinsic value, valuing a people-oriented versus thing-oriented career, and career goal (Eccles & Wang, 2016; Nagy et al., 2006; Smit et al., 2020; Tellhed et al., 2018). Our results are therefore unexpected, and show that gender differences in the intention to choose a TS course are not explained via gender differences in motivational beliefs. However, our study included a set of variables that formerly mentioned studies did not, and which could be responsible for this nonsignificant effect of gender on the intention to choose a TS course via motivational beliefs. Our findings indeed show that the relationship between gender and the intention of a TS course choice is serially mediated by gender roles and motivational beliefs, which is established with all four serial indirect effects, thereby confirming our fourth hypothesis. This is a novel empirical insight and an important contribution to the SEVT, given that it has never been tested before.

The main insights from our data were the following. First, the tested model singled out gender roles as more important factors laying beneath the relationship between gender and the intention to choose a course in TS, than the motivation for physics. This finding sheds a new light on the SEVT, given that most studies within this theory have focused on the role of motivational beliefs, and not gender roles, in the explanation of gendered educational choices for the last 40 years. However, the empirical evidence on the importance of constructions of femininity and masculinity for educational and career plans and choices is known from various qualitative studies (e.g. Francis et al., 2017; O'Connor et al., 2018; Saavedra et al., 2014). In our study,

when considering the results of simple mediations, only masculinity seems to be a significant factor that explains the relationship between gender and the intention to choose a TS course. Moreover, contrast analyses showed that this simple indirect effect is stronger than serial indirect effects through masculinity/femininity and expectancy of success. This reveals that when students are considering to choose a course in a predominantly masculine field (such as technical sciences), the masculinity of a student seems to be more important than their femininity or expectancy of success. A possible explanation for the higher importance of masculinity than femininity in the explanation of gender differences in the intention to choose a TS course could be that masculinity is congruent with this masculine educational/vocational domain. A possible hypothesis, that yet has to be tested, is that femininity could play a more important role in the explanation of a choice of a more feminine vocational domain, such as health care or teaching.

Second, our model tested four different serial mediations and all of them were confirmed. As to our knowledge, this is the first time to give empirical evidence on SEVT complex relations that have previously not been tested. Although these effects are not strong, our data supported the complex structure of the part of SEVT, showing that beneath the relationship between gender and achievement-related choices are effects of both gender roles and motivation. This analysis showed that, although femininity was not a significant single mediator of gender differences in the intention to choose a TS course, it played an important role in serial mediation effects. Also, serial effects with utility value, instead of expectancy of success as a motivation indicator, yielded (not-significantly) stronger serial mediation effects (see Table 2). This might indicate that students find usefulness of the task more important than expectations of their own success when making educational choices, which has been supported in previous research (e.g. Updegraff et al., 1996).

We would also like to point out that there was still a significant direct effect of gender on the intention to choose a TS course, while controlling for mediation effects of gender roles and motivation. This implies that there are still some other variables laying beneath the relation between gender and the intention to choose a TS course. According to the SEVT, among the factors that are important in the explanation of gender differences in educational choices are students' gender stereotypes as well as their socializers' beliefs and behaviors (Eccles & Wigfield, 2020). For example, studies show that students' stereotypes about the lack of talent or

ability of one's own gender group in an educational domain or a career negatively affected their effort or the intention to choose an activity or course in that domain (e.g. Greene et al., 1999; Author, 2010, 2017; Starr & Simpkins, 2021). In addition, longitudinal studies from the United States have shown that mothers' gender stereotypes, beliefs about their children's abilities or behaviors such as modelling and encouragement had effect on their children's own motivation or behavior in math, sports and music (Eccles, 2015; Jacobs & Eccles, 1992; Simpkins et al., 2015). However, in our study, total indirect effect was stronger than direct effect, which implies that the majority of the relationship between gender and the intention to choose a TS course can be explained by gender roles and motivation.

4.1 Limitations and Directions for Future Research

There are some methodological limitations in this study that should be taken into consideration when interpreting the results. We conducted path analyses at manifest level, leaving the results affected by the measurement error. To control the measurement error, future studies conducted on larger samples should take into consideration the testing of these relationships at a latent level. Using structural equation modelling would also allow for estimation of multiple regression equations simultaneously. Additionally, we used a cross-sectional design, so we cannot make a casualty conclusion based on these results. Longitudinal design, with ideally three time points, would provide the information on the temporal order of the constructs and directions of the effects (Spector, 2019). Although the order of variables in the model was based on theoretical argumentations inside SEVT (Eccles & Wigfield, 2020), testing whether this order is supported in the data would be an additional contribution to this research. As a criterion variable in the model, we used a measure of intention to study a TS course. The implications of the results would be stronger if we measured some objective outcomes as well, such as students' actual enrolment into those courses in the future. Although the intention of a behavior is a strong predictor of an actual behavior, readers should be aware of the intention-behavior gap (Conner & Norman, 2022). Since the future choices with time become part of the previous experience of a person, they can in return affect the expectation of success and utility value of future outcomes

(Eccles & Wigfield, 2020). Hence, future research should consider including some previous outcomes as controlling variables in the model (e.g. course GPA).

In this study we focused on educational choices in a gender-stereotypical masculine educational field. However, it would be interesting to test if gender roles and motivation mediate the relationship between gender and educational choices in a predominantly feminine field (e.g. humanities or social sciences). For instance, a longitudinal study conducted in the Netherlands showed that internalized gender role expectations affect boys' educational values and preferences, but not those of girls, suggesting that there is a lower acceptance of cross-gendered choices for boys than girls (van der Vleuten et al., 2016). Since all aspects of SEVT are situative (Eccles & Wigfield, 2020), data from different cultural contexts are of great importance. We encourage other researchers to test if these results replicate in different educational and societal contexts.

To conclude, from the theoretical perspective, we would like to highlight the importance of conceptualizing, operationalizing and exploring gender roles within the SEVT, preferably by using contemporary measures of gender roles.

4.2 Contributions

This study brings several significant contributions, including providing empirical support for the complex relations within SEVT and advancing our understanding of the gender gap in education.

Although SEVT is a widely used theoretical framework for explaining gender differences in educational choices, there is still limited empirical evidence on complex relations among its specific parts, particularly those involving gender roles. This study stands out as one of the few to examine serial mediation effects within SEVT and, to our knowledge, the first to include both gender roles and motivation in such an analysis. Furthermore, we have used a contemporary measure of gender roles specifically designed for adolescents. The results support the proposed relations within SEVT, emphasizing the significance of serial over simple mediation effects. Additionally, our findings highlight the importance of incorporating gender roles (especially

masculinity) in explaining gender differences in motivation and educational choices in a male dominated field.

Another contribution of this study is its focus on a specific school subject and science field, which makes the results easier to replicate. Since the gender gap in physics exceeds that in mathematics, and regarding that physics is a “gateway” subject to many male dominated higher education courses, incorporating the motivation for physics instead of commonly used mathematics, gives a contemporary perspective to the results. Furthermore, the study targets the intention of enrolling in the university courses in technical sciences, a field where women are nowadays majorly underrepresented, thereby enhancing the relevance of the findings.

4.3 Implications for Practice

Our findings suggest that educational interventions should target both gender roles and the motivation to reduce the gender gap in technical sciences and other male-dominated fields in higher education and careers. We propose several strategies to address this issue. First, it is essential to challenge traditional gender roles and raise awareness on their impact on students’ educational choices. For example, interventions could involve discussions on the congruence (or lack thereof) between gender roles and perceptions of academic fields, exploring the experiences of feminine individuals in male-dominated domains, and strategies for deconstructing gender roles and stereotypes. Introducing students to role models who have pursued non-stereotypical career paths, such as women or more feminine individuals in technical science professions, could help those who do not conform to traditional masculine norms envision themselves in these fields where representation is limited.

A second approach could involve enhancing motivation in subjects like physics, which some students may not perceive as relevant to their lives or future education. Curriculum adjustments could include incorporating examples that resonate beyond stereotypically masculine interests (e.g. speed of the bullet, ball or train), such as integrating topics related to people-oriented situations, relationships, and environmental care. Additionally, the explicit and implicit

curriculum should feature more examples of women in physics-related occupations, rather than confining the female representation to traditional or familial roles.

Finally, it is crucial to educate teachers and parents about the detrimental effects of traditional gender roles and stereotypes on students' motivation, educational, and career choices. Raising awareness of their potential gender biases and their influence on students' decisions is equally important. Together, these interventions could contribute to providing adolescents with gender-sensitive career guidance, both in and outside of school, encouraging them to consider a broader range of occupations free from restrictive gender norms and stereotypes.

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Appendix A

Table 3.
Regression Coefficients and Standard Errors for the Tested Mediation Model (N = 625)

Antecedent	Consequent M_1 (Femininity)			Consequent M_2 (Masculinity)		
	Coeff.	*SE*	*p*	Coeff.	*SE*	*p*
X (Gender)	-1.08	.039	<.001	0.65	.043	<.001
Constant	4.82	.059	<.001	2.20	.064	<.001
	R^2 = .55			R^2 = .27		
	$F(1,623)$ = 759.68			$F(1,623)$ = 228.76		
	p < .001			p < .001		

Antecedent	Consequent M_3 (Expectancy of Success)			Consequent M_4 (Utility value)			Consequent Y (Intention to choose a TS course)		
	Coeff.	*SE*	*p*	Coeff.	*SE*	*p*	Coeff.	*SE*	*p*
X (Gender)	0.22	.135	.109	0.23	.158	.152	0.39	.136	<.01
M_1	-0.18	.081	<.05	-0.24	.095	<.05	-0.75	.082	.36
M_2	0.28	.074	<.001	0.29	.087	<.001	0.30	.075	<.001
M_3	-	-	-	-	-	-	0.24	.052	<.001
M_4	-	-	-	-	-	-	0.40	.045	<.001
Constant	1.78	.389	<.001	1.68	.458	<.001	-0.49	.399	.22
	R^2 = .11			R^2 = .10			R^2 = .67		
	$F(3,621)$ = 25.69			$F(3,621)$ = 23.81			$F(5,619)$ = 101,66		
	p < .001			p < .001			p < .001		