

# BIOLOGY CONTENT AND CLASSROOM EXPERIENCE AS PREDICTORS OF CAREER ASPIRATIONS

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## Introduction

By at least the end of upper secondary school, students should have formed their career aspirations and chosen their study track or opted to enter the world of work. These decisions are important and influenced by many internal (Gläser-Zikuda et al. 2005) and external, volitional and nonvolitional factors shaping their career aspirations and decisions leading toward their actual occupations. There have been many attempts to explain career decisions, and some of the most commonly applied theories are (Jung, 2010) the Social Cognitive Career Theory (Lent et al., 1994) and the Career Construction Theory (Savickas, 2005).

It has become common knowledge that teachers and classroom experiences based on their teaching (Osborne et al., 2003; Zhang et al., 2018) can influence the career aspirations and occupational intentions of students. However, the delineation between the short-term influence of the discipline on students' cognitive and affective domains, working toward the motivation and attractiveness of the discipline as a school subject and long term career paths is not well established (Abrahams, 2009; Waters -Adams, 2006). According to Uitto (2014, p.1425) and based on Lent et al. (1994), an individual forms a contextual environment. In the contexts of biology careers, this is formed from "the person itself, his or her immediate environment, and the wider social-cultural environment" (p.1452). According to Trumper (2006, p.32), factors affecting interest in biology can be broadly classified as "gender, personality, structural variables and curriculum variables p.32", of which only the last is considered in this research.

Many published studies, reviewed elsewhere, (e.g. Jenkins & Nelson, 2005; Jones et al., 2000; Osborne et al., 2003; Potvin & Hasni, 2014; Prokop et al., 2007) have tried to interpret the connections between numerous factors influencing interest in, attitudes toward, intentions and actual actions toward science and biology. Consequently, the election or rejection of a career in these disciplines can rely on these factors. However, such studies are rare in Slovenia (e.g. Cerinšek Hribar et al., 2013; Zeyer et al., 2013) and mostly hide the influence of biology within the general science context, not asking respondents to answer exclusively about biology but about science and biology as part of the natural sciences. The approach using the broad term 'science', or the even wider term STEM (Science, Technology, Engineering,



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**Abstract.** *In Slovenia, as in many other countries, interest in seeking careers in science, technology and engineering-related disciplines is low, which can be recognized as a problem. The influence of general interest in biology, the content, and teaching of Biology in 9-year basic school (age 14 -15) and general upper-secondary schools (age 15 – 18) on the career aspirations of students was explored. Based on structural models built on the responses of 522 general upper secondary school students from Slovenia, it was revealed that the corresponding constructs (1) The content of Biological disciplines; (2) The Biology content taught in 9-year basic school; (3) The Biology content taught in general upper secondary school; (4) The teaching of lower secondary school Biology; and (5) The teaching of general upper secondary school Biology--are only weak predictors, if at all, of career aspirations in 15 different career streams. The greatest predictive power is a general interest in biological topics. However, the influence of the content of school curricula and corresponding teaching is a weak and even negative predictor of career aspirations in some cases.*

**Keywords:** *biology teaching, career aspirations, lower secondary school Biology, SEM analysis, upper secondary school Biology.*

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and Mathematics) in questionnaires may lead to misleading results, because opinions about and attitudes toward particular scientific disciplines, and even issues within each discipline, can be very different, therefore resulting in varying strength of any influence on career aspirations, as has been shown in the research of Šorgo et al., (2018).

From the published research findings in international studies (e.g. Eurobarometer; OECD reports; PISA; TIMMS, and similar), conducted by organizations such as the OECD or the European Parliament, some important conclusions can be extracted about the association between professional careers in science and technology-related fields. However, "the weakness of these studies is that they are performed at general science/engineering/mathematics/literacy levels, and do not necessarily reflect patterns at the discipline (e.g., Biology, Chemistry, Mathematics, Physics) level" (Šorgo et al. 2018, p.1452).

Data about enrolment in different study fields at the tertiary level and programs at the secondary school level are collected by various Slovenian governmental agencies (e.g. Statistical office) providing annual reports. Based on these data, some conclusions about the popularity of various types of schools and related career intentions can be revealed. However, factors influencing decisions to enroll in particular study programs cannot be recognized from these statistics, simply because such data are not collected. The first big divide comes at the end of compulsory 9-year basic school when students must decide about entering study tracks leading towards University programs ("Gimnazija" programs), or professional and vocational education (see details about study tracks in the section Pre-university Biology education in Slovenia). In the study year 2013/2014, 29.223 (39%) students were enrolled in general education, 33.642 (45%) students in technical and other forms of professional education, and 12.042 (16%) in the lower level and vocational education. The recent trend has been towards lower numbers of students enrolling in general programs, and greater numbers enrolling in professional and technical disciplines (Statistical office, 2015). The general rule is that students with better grades choose "Gimnazija" programs. It is a common obligation that students at the end of upper secondary education must pass the General or Vocational Matura Exams. General Matura allows enrolment in all University and higher education programs, while the Vocational Matura, with one added subject at the General Matura level, allows enrolment in some, mostly professional-oriented technical programs. At the Gimnazija level (where the Matura exams are compulsory), a good indicator of the popularity of science subjects is their selection as a first and/or second elective subject. The trend in the choice of Science subjects is U-shaped. In the first year after the introduction of the Matura exams in 1995, 26.3% of chosen elective subjects were science subjects (Biology, Chemistry and Physics); however, someone cannot tell from these data how many students chose Biology. In subsequent years, there was a steady decline in enrolment in science subjects, with a low point in 2004 (17.3%). After this year, interest in elective science subjects rose steadily, reaching 29.0% in 2015. This upward trend cannot be attributed to any particular cause because of the lack of appropriate studies.

An important indicator of the perceived status, popularity and attractiveness of content, classroom experience and teaching practices in science in general and Biology in particular at the upper secondary school levels should be enrolment in actual tertiary-level study programs. Nevertheless, even with the knowledge of the data about actual enrolment of about half of the annual generation of youth (Statistical office, 2015) in different study streams, it remains difficult to attribute their decisions to previous school experiences. This is because selection procedures in high-interest programs compel many of them to involuntarily enroll in programs that were not initially on their wish list; however, owing to low interest, these still had study spaces available. Additionally, many higher education programs such as Forestry, Medicine, Veterinary Science or Agronomy lack exact counterparts in general secondary school Biology. Ploj Virtič and Šorgo (2016) connected the lack of interest in engineering and technology studies to a deficit of information provided in the curricula of the related subject(s) at the secondary school level. However, their explanation is weak, and without additional studies, it can be regarded merely as speculation, though held by many in Slovenia (for a review of this position, see Ploj Virtič & Šorgo, 2016). As reported by Šorgo et al., (2018), the empirical reason for rejection of this claim is that in general upper secondary schools, courses in Medicine, Law and Economy are also not provided. Nonetheless, in these three programs, interest in enrolment is greater than the available study places offered. According to Šorgo et al., 2018, at the general upper secondary school level ("Gimnazija" program), probably the most important indicator of the popularity of Biology is enrolment in elective Matura Biology courses (see the chapter "Pre-university Biology education in Slovenia" for details). Moreover, even there it is not known whether enrolment is a result of intrinsic or extrinsic motivation or a combination of different interests (Janštova & Šorgo, 2019). An extrinsic motivator toward the selection of one of the Science subjects (Biology, Chemistry, Physics) could be the elective criteria of popular University programs such as Medicine, Pharmacy, and Veterinary Medicine, where, in the case of a surplus of applicants, grades from Science disciplines provide applicants with an advantage.



Before building the models, an assumption was that one of the important roles of general education should be the provision for students of a range of career options that is as wide as possible. However, in this process, each subject should be biased toward supporting career aspirations in its own field and leaving the individual student to make the final decision.

### *Pre-university Biology Education in Slovenia*

Only a brief overview of Slovenian pre-tertiary Biology education is provided. The interested reader can find additional information online on a number of Internet sites. However, the general impression is that Slovenian school system “can be regarded as rigid in structure and content” (Šorgo et al., (2018, p.1450). The programs and the content of the subjects are prescribed by syllabi approved by governmental bodies, allowing little space for elective content. Because of the external final examinations, teachers conform to the Matura catalogues, syllabi and textbooks based on these. However, the legislation and the didactic recommendations that form part of each syllabus (Šorgo & Špernjak, 2012) do allow flexibility and pedagogical autonomy in teaching the prescribed Biology content. From the perspective of the students, this can mean that they will have different classroom experiences in every single topic. Because of teacher autonomy, Biology can be taught in different ways, e. g. with or without the experience of group work, inquiry and problem-based approaches, contact with living organisms, and similar.

Nine-year basic school is compulsory and covers primary (the first and second 3-year cycles) and lower secondary school (the third cycle) levels. All public schools and most private schools follow the same program, curricula and subject syllabi, as approved by governmental bodies. Exceptions from the rule are a minority of schools following Waldorf and Montessori pedagogy. Compulsory subjects and weekly hours dedicated to the subjects with Biology content in compulsory 9-year public schools (Šumak e. al., 2017) are presented in Table 1.

**Table 1**

*Compulsory subjects and weekly hours dedicated to the subjects with Biology content in compulsory 9-year basic public schools*

Subject / Grade	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	4 <sup>th</sup>	5 <sup>th</sup>	6 <sup>th</sup>	7 <sup>th</sup>	8 <sup>th</sup>	9 <sup>th</sup>	Sum
Environmental Studies	3	3	3							315
Science and Technology				3	3					210
Science						2	3			175
Biology								1.5	2	116.5

The diversity of educational options in upper secondary education is greater. These options can be broadly divided into 4-year “Gimnazija” programs leading to university studies, and technical and vocational education. The main intention of general secondary education is to prepare students for the school-leaving General Matura Exams (Šorgo et al., 2018; Šumak et al., 2017). The Matura has a double role, serving as both the final, compulsory school-leaving exam and as the entrance exam for university studies. The “Gimnazija” program is further structured into streams. The majority of students are enrolled in the general stream; however, some schools offer classic, sport, economic, arts and technical streams, with the provision of subjects not offered in the general stream. However, regardless of the stream, Biology is compulsory at least in the first two years (140 hours), and in the general stream in the first three years (two lesson hours per week) – making a total of 210 hours. For those who choose the Matura exam in Biology, an additional 140 lesson hours are obligatory in the final year, which amounts to 350 lesson hours. Compulsory content (210 hours) of the “Gimnazija” level Biology course covers the following topics: Life on Earth; Structure and function of a cell; Genes and inheritance, Evolution, Structure and function of organisms, Ecology; and Research and experiments. The Matura program in Biology (105 h) includes the following topics: Cell biology; Human physiology; Ecology, Biodiversity and Evolution; How does Science work? From the elective courses, students in the Matura program can choose one of the following 35-hour modules: Biotechnology and Microbiology; Biological basis of healthy life; Animal behavior; Humans and natural resources.



*The Aims of the Research and Research Questions*

The present research follows the research by Šorgo et al., (2018). The main difference is that the previous study explored the influence of combined opinions about the content, the content of the subject, and related teaching practices in six different STEM subjects on aspirations to become researchers or teachers. In the present research, the interest lay in exploring the influence of similar constructs of Biology as taught in basic and general secondary school on students' career aspirations in 15 different economic sectors from the list of the Slovenian Statistical Office (Statistical Office, 2015). The research questions follow (Šorgo et al., 2018, p. 1457) with the difference, that only Biology is considered:

Are career aspirations affected by

- 1) Opinions about the content of Biological disciplines?
- 2) Opinions about the Biology content taught in 9-year basic school?
- 3) Opinions of the Biology content taught in general upper secondary school?
- 4) Opinions about teaching/learning (classroom) experiences during 9-year basic school Biology?
- 5) Opinions about teaching/learning (classroom) experiences during general upper secondary school Biology?
- 6) Are any or all of the above affected by gender?

**Research Methodology***Research Model*

The research model follows statistical reasoning and procedures as applied in Šorgo et al., (2018). In this research, the model includes five latent variables as predictor variables, and students' career aspirations to work in one of the fifteen economic sectors (e.g. health, education) as an outcome variable. The theoretical model is presented in Figure 1. Each latent variable included in the model has five dimensions, as developed in Šorgo et al., (2018). They are: 1) fascinating – boring (F-B); 2) interesting – mundane (I-M); 3) important – unimportant (I-U); 4) attractive – unattractive (A-U); 5) exciting – unexciting (E-U).

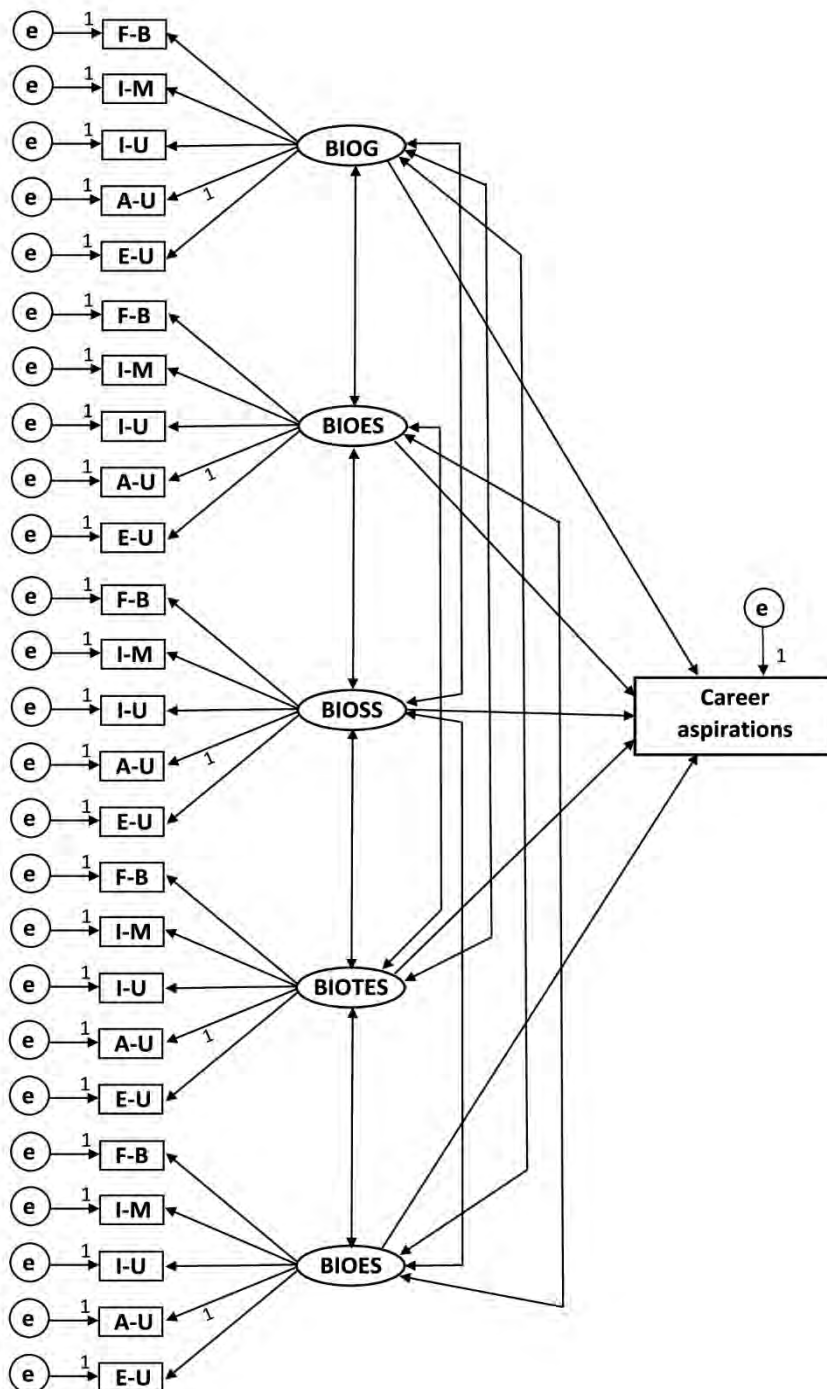
The list of the latent variables reflected in the research questions was as follows (Šorgo et al., 2018):

- 1) BIOG: Opinions about the content of Biological disciplines;
- 2) BIOES: Opinions about the Biology content taught in basic 9-year school;
- 3) BIOS: Opinions about the Biology content taught in general upper secondary school;
- 4) BIOTES: Opinions about classroom experiences during basic 9-year school Biology;
- 5) BIOTSS: Opinions about classroom experiences during general upper secondary school Biology.



**Figure 1**

*Hypothesized research model based on opinions about the content and teaching of Biology as predictors of students' career aspirations*



Later in the statistical analyses, each of the constructs was initially tested by following the principles of Exploratory Factor Analysis (EFA) and follow-up Confirmatory Factor Analysis (CFA). Concurrent models were tested by the application of Structural Equation Modelling (SEM).



### *Predictor Variables*

Five latent variables based on opinions about the content of Biology and corresponding classroom practices (see research model) were hypothesized to influence the career aspirations of the students. The reasoning followed the theoretical assumptions of social cognitive career theory (Lent et al., 1994). Therefore, the reasoning was that achievements in and attitudes toward a particular discipline (subject) are influenced by a combination of personal interest in and opinions about the particular discipline (Šorgo et al., 2018). Consequently, such opinions and attitudes in combination with self-efficacy and motivation (Janštova & Šorgo, 2019) can influence major decisions concerning a lifelong profession. A long row of decision points involves enrolment in elective courses, after-school and leisure activities, and decisions about choosing a secondary school, a tertiary study program, etc. As stated in Šorgo et al., (2018, p. 1456), "In an ideal world, opinions about a discipline would be aligned with opinions held toward the content taught in elementary and secondary schools in their influence on the career path". Because of teacher autonomy, the content can be taught in different ways; however, the influence of different teaching strategies on career aspirations is beyond the scope of this research.

The conclusions of many research studies claimed that students' experiences with teaching at different school stages can greatly influence career paths directly or indirectly in a positive or negative way (e.g. DeWitt, et al., 2013; Gilmartin et al., 2006; Osborne et al., 2003). Aschbacher et al. (2010) recognized three groups of students: "High Achieving Persisters, Low Achieving Persisters, and Lost Potentials" (p.564). In the Slovenian context, we can connect High Achieving Persisters to studies such as Medicine and Psychology, where there is a constant surplus of applicants for these programs. Complex personal factors were not considered in this research. The reason for the exclusion of personal factors was to limit the number of constructs in the models.

To explore opinions, the same semantic scales were used in all considered constructs in the case of EFA and latent variables in the case of CFA. Seven-point semantic differential scales with bipolar adjectives (Gardner, 1995) were chosen for the assessment. The adjective pairs reflected the dimensions forming a latent construct. The pairs were adapted from the STEM Semantics Scale (Tyler-Wood et al., 2010), and tested in research by Šorgo et al., (2018). They are listed in the research model section.

The difference related to the constructs occurred in the leading statements (Šorgo et al., 2018), which were as follows:

- 1) Biology content (e.g. Botany, Zoology, Genetics, Microbiology, Agronomy, Veterinary Science and Medicine are:
- 2) The majority of the Biology content taught in basic school was:
- 3) The majority of the Biology content taught in upper secondary school was:
- 4) The teaching of Biology in primary basic school was:
- 5) The teaching of Biology in upper secondary school was:

Five research hypotheses were assembled. All hypotheses follow the same principle, that each latent construct has a significant influence on career aspirations in each of the considered career options.

Principal Component Analysis (PCA) and calculation of Cronbach's alpha (Gardner, 1995) were chosen to assess the internal consistency and unidimensionality of the scales. Extracted values of component loadings are presented in Table 4 in the Results section.

A potential source of bias in the evaluation of the influence of basic school is possible. However, given that Biology in lower secondary school is taught in the last two years of 9-year school (Table 1) when students are 14 – 15-years old, and the age of the survey was 17 – 18-years, it was hypothesized that memory bias should not be too large. Later, when different models were tested, it was shown (models not presented) that exclusion of those constructs connected with the basic school (BIOES, BIOTES) did not influence the model fit or predictive power of the shortened model.

### *Career Aspirations as Outcome Variables*

Career aspirations to be employed in various economic sectors can be identified as behavioral intentions (Ajzen, 1991; Ajzen & Fishbein, 1977). According to the theory, behavioral intentions are predictors of actual behavior under volitional conditions. Both are moderated by a number of personal and external factors or a combination of these. Actual behavior was not included in the models considered in recent research and the models as applied in Šorgo et



al., (2018), because of the inability to identify future occupation in advance. The reasoning follows the assumption that knowledge about intentions is a strong predictor of actual behavior, even under non-volitional conditions, which was the conclusion of a number of studies (e.g. Davis et al., 2002; Ingram et al., 2000; Millar & Shevlin, 2003).

Given the intention to ensure exclusion of as many non-volitional conditions as possible, students were not asked about their foreseen choice after the end of upper secondary education. At this career stage, there are potentially two options available and open to the students. The first one is to leave the study path and enter the world of work, and the second is to continue education into tertiary institutions. Alternatively, to assess their career aspirations after studying, several options were considered. The idea of providing a list of actual professions was abandoned early because the number of professions amounts to thousands. Therefore, agreement or disagreement with their preference for being employed in various economy sectors after ending their studies was elicited (Šorgo et al., 2018). By such an approach, the relative position of each sector on a 7-point scale was obtained.

The leading statement for assessing career aspirations was the same as in the study by Šorgo et al. (2018 p. 1458): "After finishing my studies, I would prefer to be employed in an organization best labelled as:". Fifteen options (e.g. research and development, education, engineering), following classifications by the Slovenian Statistical Agency, were provided (Table 2). The response format was a 7-point Likert scale in a range between completely true (1) and completely untrue (7). Between margin values, only numbers without explanations (e.g. partially true) were provided.

#### *Moderator Variables*

People differ depending on an almost limitless number of characteristics and traits. It is impossible to include all of these in models, so it is always possible to miss, underestimate and overestimate some of them. In the tested models, personal characteristics were not considered as predictor variables but regarded as moderator variables (in the sense applied in the Unified Theory of Acceptance and Use of Technology (UTAUT) (Šumak & Šorgo, 2016; Šumak et al., 2017; Venkatesh et al. 2003).

Among personal characteristics, as moderator variables, the only gender was considered. Differences in attitudes, interests, enrolment and career selection between genders are probably the most often reported outcomes of many studies. However, statistical differences cannot be attributed to biological sex alone, but are the product of gender-based stereotypes, along with the cultural and societal context, which influence decisions through perceived behavioral control. Interest in science also changes with age (e. g. Potvin et al., 2018; Randler et al., 2012). From the study of Baram-Tsabari and Yarden (2011), it can be revealed that the gender gap does not exist in early childhood but increases by the end of high school. Views are loaded with stereotypes about girls' preference for biology, and boys' preference for technics and technology. Because the research included only students from the last two years of upper secondary schooling, age was not considered as a moderator variable.

After testing differences between genders in terms of career aspirations (Table 2), the finding was that these differences were statistically significant; however, the differences, calculated as effect sizes, do not exceed small values (the largest calculated effect size was .33). Based on the test results, which showed small differences, it was considered that gender as a moderator variable is excluded from the models.

The sample comprised students from the final and pre-final grades of the general secondary-school ("Gimnazija") program (17 – 19 years old). All statistical differences between these two groups were statistically nonsignificant ( $p < .05$ ), so they were also not considered in our models.

#### *Sampling and Sample*

The online survey started on 17th December 2015 and ended on 17th March 2016. The questionnaire about the influence of Biology and Biology teaching on career aspirations was part of a larger survey based on concerns about the insufficient number of students who would like to enter university streams leading to teaching careers in STEM subjects in Slovenia (Šorgo et al., 2018). For the present report, only variables related to the research questions were extracted from the pool.

A number of teachers and headteachers were informed about the existence of the link to the survey provided at the Slovenian free 1ka online survey system. They were asked for help to disseminate information about the survey and share the link with their students and other teachers. Because Slovenia has fewer than 120 upper secondary schools at corresponding levels, it was possible for us to directly contact the teaching staff at all schools.



Therefore, at least potentially, every enrolled student was offered the chance to participate in the survey. Many teachers allowed whole classes to access the link and respond in school computer classrooms and multimedia classrooms. This form of data collection allowed us to assume the representativeness of the sample.

Participation was anonymous, and voluntary and based on the provision of an opt-out choice at any point in the process of data collection. Benefits in any form were not foreseen for teachers, their students or any incidental visitors to the survey system. Classroom survey instruments and procedures of this type do not need the approval of ethical committees or similar bodies, according to the Slovenian rules. However, the permission of the headteachers should be obtained.

During the three-month period, 1752 visits to the questionnaire were recorded, of which 1149 (67%) started responding. 721 (42%) of these completed the survey (62.7% of those who started responding). From the data set, we excluded all respondents who did not qualify as students in the last two grades (3rd and 4th) of general upper secondary school ("Gimnazija" program). After exclusion of cases (students) with missing responses in their data sets, responses from 552 students were considered in the statistical analyses. This number roughly corresponds to about 10% of the total number of students enrolled in the "Gimnazija" program from these two generations in Slovenia in the school year 2015/16. The number of students from a sample of 522 enrolled in the 3rd study year was 328 (59.4%) and in the 4th study year, 224 (40.6%). The number of females was 355 (64.3%) and of males 197 (35.7%).

### *Statistical Analyses*

The descriptive statistical analysis followed procedures and calculations as applied in the study by Šorgo et al., (2018), and thus are described here only briefly. Prior to further analysis, all cases with missing data were deleted. Normality of the variables of interest was checked by use of the Kolmogorov – Smirnov test at a .05 significance level. Owing to the ordinal nature of the items and violation of assumptions of normality, a nonparametric Mann-Whitney test was performed to compare the significance of the differences between genders, and enrolment in a class (Erceg-Hurn & Mirosevich, 2008). The effect size was calculated using the formula as provided in Field (2009, p. 550). However, from analysis of skewness and kurtosis (results are not presented), it was realized that a) skewness of the predictor variables did not exceed a value of .9 (.02 – .9), and the standard error of skewness is .10, and b) the values of kurtosis did not exceed -1.13 (-.06 – -1.13), and the standard error of kurtosis is .21. All values fall below the suggested thresholds for preventing SEM analyses (Byrne, 2016; Kline, 2011).

### *Reliability and Validity of the Structural Equation Model (SEM)*

Initial Exploratory Factor Analysis (EFA) was performed on all constructs (latent variables). Prior to analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were checked, showing the appropriateness of the matrices for further analysis. PCA with Direct Oblimin rotation was applied because of the expected correlations between extracted components in each considered construct (Field 2009). Later it was revealed that because of the unidimensionality of all constructs, the choice of rotation had no practical consequences. Owing to the non-normal distribution, the results from PCA should be considered with caution (Basto Pereira, 2012). However, according to Lei and Lomax (2005, p. 16), the large sample meant that "we might not need to be extremely concerned with their effects because the worst effect of the bias is generally considerably less than 10%". All constructs met the criteria of unidimensionality and appropriate Cronbach's alphas; therefore, they were included in the models without alteration (Šorgo et al., 2018). For performing descriptive statistical procedures and EFA, the SPSS 24 package was applied.

Factor loading above .50 and Composite Reliability (CR) above .70 assure the reliability of the latent variables included in the model (Fornell and Larcker, 1981). The validity of the model was observed with the application of CFA and SEM as a procedure. Convergent Validity of the model was checked by calculating 1) Average Variance Extracted (AVE > .50); 2) Discriminant Validity by Average Shared Variance (ASV < AVE); and 3) Maximum Shared Variance (MSV < AVE) (Hair, 2010). The Construct Validity was checked by observing thresholds of the number of fit indices as provided by AMOS 24. Indices, as follows were checked (Byrne, 2016): 1) RMSEA < .08 (Root Mean Square of Error Approximation); 2) GFI > .9 (Goodness of Fit Index); 3) CFI > .9 (Comparative Fit Index); 4) TLI > .9 (Tucker Lewis Index); 5) PNFI > 0.9 (Parsimony Normed Fit); 6) AGFI > .8 (Adjusted Goodness of Fit); 7) NFI > .8 (Normed Fit Index) and 8) Chisq/df (Chi-Square/Degrees of Freedom) (Byrne, 2016; Hair, 2010).





## Research Results

### Career Aspirations

Frequency of and descriptive statistics for career aspirations are presented in Table 2.

**Table 2**

*Frequencies and descriptive statistics of career aspirations in the listed economic sectors on a 7-point scale (N = 522)*

Rank	Type of organization	F1%	F2%	F3%	F4%	F5%	F6%	F7%	Md	M	SD	r#
1	Research and development	17.8	16.1	16.5	18.5	9.6	9.6	12	3	3.63	1.96	M .15
2	Society	23	12.1	13.9	17	8.3	8.2	17.4	4	3.70	2.14	F .33
3	Health and social security	20.8	14.5	11.8	14.1	12	10.1	16.7	4	3.79	2.14	F .28
4	Education	13.2	12.7	12.9	17.6	11.4	11.4	20.8	4	4.19	2.06	F .22
5	Culture and Entertainment	8.9	12.1	12	18.7	14.5	12.1	21.7	4	4.41	1.96	F .15
6	Information and Communication	6.9	11.2	15.2	19.6	12.3	13.6	21.2	4	4.45	1.90	.05
7	Engineering	10.5	8.9	13.2	18.1	12.7	14.9	21.7	4	4.45	1.98	M .30
8	Finance	10	8.9	13.6	17	11.2	14.3	25	5	4.54	2.01	.01
9	Environmental and nature protection	6.2	7.8	14.9	18.8	15.4	14.9	22.1	5	4.63	1.84	.02
10	Tourism and hospitality	7.2	8.5	10.7	15.9	14.1	16.7	26.8	5	4.78	1.93	.09
11	Law	8	7.4	9.4	14.1	10.3	18.5	32.2	6	4.96	1.98	.05
12	Defense and safety	5.4	8	10.1	16.1	11.4	17.6	31.3	5	4.98	1.89	M .14
13	Trade	4.3	4.9	9.4	17.2	16.3	19.6	28.3	5	5.08	1.74	.02
14	Production and manufacturing.	6.7	4.7	8.2	12.9	14.3	20.5	32.8	6	5.16	1.86	M .26
15	Agriculture and Hunting. Forestry. Fishing	4	4.2	5.4	10.9	9.4	16.1	50	6.5	5.66	1.75	M .17

Note. *r* = effect size. #M = male; F = female; Md = Median; M = Mean; SD = Standard Deviation

Results in Table 2 are ordered by increasing mean; therefore, interest is highest in the career of a researcher, and the lowest interest is in agriculture, hunting, forestry, and fishing careers.

### Descriptive Analyses on Predictor Constructs

Descriptive analyses for five constructs, considered as important for the formation of informed opinion about Biology are presented in Table 3.



**Table 3***Results of descriptive statistics on the opinions*

Constructs	Descriptors	F-B	I-M	I-U	A-U	E-U
BIOG	Mode	3	1	1	4	3
	Md	3	3	2	4	4
	M	3.57	3.11	2.69	3.68	3.80
	SD	1.83	1.75	1.73	1.90	1.85
BIOES	Mode	3	3	3	3	4
	Md	4	3	3	4	4
	M	3.85	3.46	3.41	3.89	4.09
	SD	1.76	1.73	1.68	1.76	1.76
BIOSS	Mode	4	3	3	3	4
	Md	4	3	3	4	4
	M	3.97	3.49	3.38	3.99	4.14
	SD	1.83	1.80	1.79	1.86	1.82
BIOTES	Mode	3	4	3	3	4
	Md	4	4	3	4	4
	M	3.92	3.71	3.58	3.91	4.07
	SD	1.87	1.87	1.74	1.85	1.79
BIOTSS	Mode	3	4	3	4	4
	Md	4	4	3	4	4
	M	4.22	3.88	3.66	4.17	4.33
	SD	1.89	1.90	1.90	1.89	1.83

Note: Central tendencies of a 7-point scales in a range from 1 (first adjective in a pair) to 7 (second adjective in a pair) are presented.; Md = Median; M = Mean; SD = Standard Deviation

#### Reliability and Validity of the Constructs

All constructs later considered as latent variables in the SEM models passed the initial criteria for construct formation (see the Research Methodology section for details). Results of reliability analysis and PCA are presented in Table 4.

**Table 4***Results of reliability analysis, PCA and component loadings of opinions*

	BIOG	BIOES	BIOSS	BIOTES	BIOTSS
Cronbach's Alpha	.93	.94	.95	.97	.96
Explained variance	75.05	80.75	82.53	87.98	85.48
Eigenvalue	3.75	4.04	4.13	4.40	4.27
F-B	.90	.93	.93	.95	.94
I-M	.89	.90	.91	.95	.93
I-U	.75	.83	.84	.90	.86
A-U	.91	.94	.94	.95	.95
E-U	.88	.90	.92	.94	.94



**Table 5***Composite Reliability (CR), Convergent (AVE) and Discriminant validity (MSV, ASV) measures for all models*

	CR > .70	AVE > .50	MSV < AVE	ASV < AVE
BIOG	.92	.69	.67	.36
BIOES	.94	.76	.63	.31
BIOSS	.95	.78	.71	.39
BIOTES	.97	.85	.63	.23
BIOTSS	.96	.82	.71	.33

**Table 6***Correlations (discriminant validity) between constructs*

	BIOG	BIOES	BIOSS	BIOTES
BIOES	.60***			
BIOSS	.82***	.57***		
BIOTES	.39***	.79***	.37***	
BIOTSS	.69***	.51***	.84***	.39***

*Note. \*\*\*  $p < .001$* 

The Fit indices (Table 7) in the hypothesized models did not pass the suggested threshold values. Additionally, the differences between different economical branches are minimal, so they are not reported.

Based on the correlations and calculated indices, there existed two concurrent options. The first option was to delete items just to increase fit; the second one was to leave items in constructs at the cost of lower predictive strength of the models. For example, by itself, deletion of dimension I –U (important – unimportant) would significantly improve model fit (see Table 7) and put them above recommended thresholds in most cases. Additionally, by application of modification procedures such as connection of error terms and deletion of items based on covariance of residuals (Byrne, 2016), it was possible to raise indices, However, to conserve breadth and preserve dimensions, the second option (Byrne, 2016; Kline, 2011; Schreiber et al King, 2006;) was chosen.

**Table 7***Model fit indices for the career aspiration to work in Health and Social Security*

Fit index and recommendation	Model 1#	Model 2
ChiSq (ns)	3356.1	795.1
df	295	175
ChiSq / df < 3.00	11.4	4.5
RMSEA <.08	.14	.08
GFI >.90	.65	.86
AGFI >.80	.58	.82
CFI >.90	.82	.96
TLI >.90	.80	.95
NFI >.80	.81	.94
PNFI >.90	.73	.79

*Note. #Model 1 = Hypothesized model; Model 2 = Deletion of important – unimportant dimension*

Factor loadings of latent variables as predictors toward career aspirations are presented in Table 8.



**Table 8**

*Path coefficients of latent variables (BIOG, BIOES, BIOSS, BIOTES, BIOTSS) as predictors of career aspirations toward working in an organization belonging to the economic sector.*

Rank	After completing my studies, I would prefer to be employed in an organization best labelled as:	Explained variance	BIOG	BIOES	BIOSS	BIOTES	BIOTSS
1	Health and social security	.17	.47	-.10	-.03	.09	-.02
2	Research and development	.14	.39	-.14	.16	.01	-.04
3	Environmental and nature protection	.13	.32	-.03	-.08	.08	.13
4	Society	.05	.08	.26	-.44	-.10	.19
5	Information and Communication	.03	-.12	.06	-.19	-.03	.16
6	Finance	.02	-.08	.18	-.19	-.15	.14
7	Engineering	.02	-.03	-.10	.09	-.05	.00
8	Culture and Entertainment	.02	.09	-.07	-.19	.18	.01
9	Agriculture and Hunting, Forestry, Fishing	.01	-.03	.00	.13	-.02	-.02
10	Defense and safety	.01	-.01	-.09	-.08	.08	.17
11	Law	.01	.02	.01	-.15	.02	.13
12	Trade	.01	.02	.17	-.16	-.14	.11
13	Tourism and hospitality	.01	.08	.07	-.14	-.02	.08
14	Education	.01	.07	.03	-.17	.02	.11
15	Production and manufacturing (Industry, Civil Engineering, Traffic and similar).	.00	-.01	-.08	.01	.08	-.03

Results in Table 8 are ordered by decreasing variance ( $R^2$ ), showing the influence and explanatory power of Biology on career aspirations to work in the listed economic sector, with Health and Social Security at the top, and Production and Manufacturing at the bottom of the table.

## Discussion

When students were asked about career aspirations to be employed in organizations from a variety of economic sectors, they reported their wish independently for each sector, allowing comparisons of the attractiveness of each sector. From Table 2, it can be seen that the top three choices on the student wish list are careers in Research and Development, Society, and Health and Social Security. The first option was slightly more attractive to boys, and the latter two to girls. Only in two items (Society, and Health and Social Security), was the mode of response one (1), showing that more than one-fifth of the students express a strong wish to choose these careers. In all other career track choices, the mode was seven (7), reflecting the relative unattractiveness of these careers for a substantial number of students. At the end of the list were positioned Production and Manufacturing (Industry, Civil Engineering, Traffic and similar), and Agriculture and Hunting, Forestry, Fishing. Engineering as a core STEM discipline was positioned in seventh place, which does raise serious concern. It is beyond the scope of this article to comment about possible reasons for the differences outside the predictive role of opinions about Biology as hypothesized by our models. However, from the results, some alarming messages can be deduced. Nevertheless, there probably should not be concern about attracting sufficient numbers of persons to work in the Research and Development sector, as one of the concerns of the OECD and the European Union, as revealed from their documents (Ploj Virtič & Šorgo, 2016). However, more effort should be made to attract a greater number to continue their careers in STEM-related studies and follow-up careers.

All individual constructs (latent variables) considered in the study (BIOG, BIOES, BIOSS, BIOTES, BIOTSS) do have the appropriate statistical properties to allow their inclusion in the proposed models (Kline, 2011; Šorgo et al.,



2018; Šumak & Šorgo, 2016). Descriptors of individual items and their component loadings are presented in Tables 3 and 4. Analysis of the individual dimensions as applied in semantic scales was beyond the scope of this research. However, it can be said that general opinions about Biology are much higher than related opinions about content and teaching practices in the classroom, which can raise concerns about the quality of teaching. From Table 3, it can be recognized that positive views are the highest when talking about overall interest in and importance of general biology (mode = 1). All other values are neutral (4) or slightly below (3) the midpoint of the scale, showing neutral or positive weak attitudes on the part of the majority. All component loadings (Table 4) are high; however, the pattern shows that importance loadings are the lowest in all constructs. In connection with the results provided in Table 3, it can be concluded that Biology is recognized as more important than other corresponding dimensions. While there is little to be done by an individual teacher to change the prescribed content of school subjects, there is considerable space for improvement of teaching to become more fascinating, interesting, attractive, exciting, and last but not least, important.

Results presented in Table 5 show that all considered values for the measurement models passed the initial convergent validity check (Segars, 1997). However, from the correlations between constructs (Table 6), we can recognize that two correlation coefficients are close to the recommended threshold (.85). It was possible to decrease correlations between constructs by deleting some items from the pool, or even constructs; however, we did not perform this operation.

From the path coefficients of the models and explained variances (Figure 1, Table 8), it can be recognized that the chosen constructs are only weak predictors, if any, of aspirations to choose most of the careers on offer. General interest in biology is a statistically significant positive predictor only for careers in Health and Social Security, Research and Development and Environmental and Nature Protection, a finding which could have been expected. However, the lack of connection to Life Science disciplines, such as Agriculture, Hunting, Forestry and Fishing, was not expected. What is more, only the content of basic school Biology is a positive predictor for careers associated with society, and Biology content in secondary school is a negative predictor for careers associated with the society. All other values are statistically nonsignificant positive or negative predictors. Special concern should be addressed to the insignificant influence of classroom experience on the wish to become an educator. The pattern was already recognized in the research of Šorgo et al. (2018), where it was found that Science disciplines (Biology, Chemistry, and Physics) somehow influence career aspirations to become a researcher, but not to become an educator. Even more, the correlations to become a researcher and to become a teacher were non-existent, showing one of the possible reasons for low interest in becoming a science teacher.

It was expected beforehand that there would be differences in the influence of opinions about Biology on different career streams. The connection between interest in Biology content and the ambition to work in the health sector can be regarded as a proof of the concept because a large part of education about humans is dedicated to health education as a part of Biology. However, explanation of the missing link between Biology and Agriculture, Hunting, Forestry and Fishing, and the very weak connection with careers in Environmental and Nature Protection is harder to explain, knowing that a number of related learning goals are present in current syllabi. Based on the outcomes of these models, other factors not included in the study must be more important as predictors of career aspirations. This is valid even for streams where the influence of Biology would be expected. From the current research models, it is not possible to attribute career aspirations to any other factor, because data to support or reject such assumptions was not collected. Even in the stereotypical influence of gender, where boys were slightly more enthusiastic than girls, the differences were mostly small, with effect sizes below the 0.3 value.

It is difficult to explain the findings from the recent research; however, at least for school Biology, the most probable explanation of this pattern is that it is "the result of the primary academic nature of Biology, which lacks connections with the other school subjects" (Šorgo, 2010) or with the world beyond school. However, findings do not exclude the possibility that as the most important school-related factors leading to careers in Life sciences are some outstanding teachers. At the moment, it is not possible to deny such an assumption; however, it seems that Biology, as taught in Slovenia, is for most students, in Tranter's (2004) words, "Dull, lifeless, and boring".

Finding that school Biology, as a part of the Science family of subjects, is not a signpost toward related careers is counter-intuitive, but not new. Uitto (2014, p. 1437) wrote: "On average, students' attitudes to school science and mathematics were positive, mathematics and biology being the most favored subjects. However, it is evident that the students did not consider science subjects or mathematics very important for their future career plans". This finding is in line with the Slovenian study.

A full explanation about the relative unimportance of school Biology for career aspirations needs additional



research. It is only too easy to blame curricula and teaching practices separately; however, we suspect that, just as we cannot separate structure from function in biological structures, we cannot separate content from the way it is taught. In Slovenia as the country of interest, findings indicate (Šorgo, & Špernjak, 2007) that students would prefer active learning experiences in Biology class. However, from the work of Abrahams (2009), it was possible to reveal that even active methods such as laboratory work do not provide motivation for future careers but are still preferred by students over other teaching methods.

Perhaps one reason why school biology seems to function as an isolated entity without serious influence or at least correlation with the outside world is the trend as revealed by Tomažič and Vidic (2009). A finding of their study was that enrolment in programs for prospective Biology teachers was chosen by only a marginal minority, and even for a number of those who enrolled, this was not their first choice (Tomažič & Vidic, 2009).

## Conclusions

Findings of the current research can be summarized as follows: (1) Only general interest in Biology can be recognized as a weak predictor of career aspirations in economic sectors, Health and Social Security, Research and Development, and Environmental and Nature Protection; but not as expected in Agriculture, Hunting, Forestry and Fishing. (2) Content of basic and upper secondary school Biology and corresponding teaching/learning classroom experiences do not significantly influence any of the STEM-related careers. (3) Differences between girls and boys show that boys are more enthusiastic about Biology, but any differences are small.

From the results of the current study, it can be recognized that school biology is, in the words of Douglas Adams (2017), 'mostly harmless'. Based on this finding practical implications for the future development and improvement of the syllabi of Biology and related educational practice should be elaborated. While teachers do not have control over the influence of the out-of-school factors their "battlefields" should be their classrooms. Probably the easiest intervention of the teachers, inside the current frameworks can be in provision to the students a possibility to recognize that biology is mostly not only a school discipline, may be connected with health and environmental education, but an applicative science as well. Potentials of biological knowledge realized by professionals and in some cases by amateurs must be emphasized and illustrated by cases. Therefore, connections between what is taught in schools must be established within and between "real-world" phenomena and problems. What is the best is the knowledge that the practices, how to do it, are well known and promoted by many, however, by different reasons do not find their way into every classroom. If succeeding in this, the question "Why should we learn this topic" will become obsolete.

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## Availability of the Primary Data

Primary anonymized data are available on request from the authors.

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