The Slovenian Model of Scientific Research Work of Secondary School Students and their Participation in Competitions as Motivation for Career Choice

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Abstract:
Research in education plays an important role in maintaining curiosity and training skills. It is primarily used in the classroom, but can also be found in everyday life without us even realising it. The research work includes the views of young researchers from Slovenian secondary schools who participated in a research assignment within the Association for Technical Culture of Slovenia (ATCS) between the years 2010 and 2017 and won the gold award. We found that carrying out the research assignment helped the young researchers on their path in life and on their way to success. The correlation test of the chosen research pool showed that there is no statistically significant relationship between the chosen research area in secondary school and further university or professional orientation.

Keywords: Research work, Young researchers, Motivation, Education, Career choice, Association for Technical Culture of Slovenia

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1. Introduction

It is common to come into contact with research or project work at some point (Petek, 2012). Research work in itself means gathering one's own thoughts and ideas, collecting data and dealing with a specific problem. When young people decide to undertake a more extensive project work, which means additional success and progress for them in the future, it is important that they are encouraged by the surrounding society. Various sources of support include relatives, peers, but also mentors and various institutions that help young people to achieve excellent results. Through the research approach two fundamental goals of education are pursued: to maintain the individual's curiosity and continuing interest in knowledge and to develop the skills required for independent problem solving (Petek, 2012). To achieve these goals, one of the key factors is motivation, i.e. encouragement, maintenance and direction of the individual's activities to achieve the goal (Kompare, 2009). In addition to motivation, self-confidence is also necessary, which shows us what we want to achieve and how we will achieve it. A key role in motivation in research is played by the manager, who must positively encourage the researchers, listen to them and find out what the researcher wants to achieve. A good manager also encourages motivation by helping to solve problems, by acknowledging also negative results, by boosting self-confidence and by making the work enjoyable. Both, praise and reprimand are extremely important in research work (Uranič, 2008). As mentioned earlier, institutions are also responsible for a large part of motivation by supporting designers in various ways. Such method was demonstrated at a local school in Ljubljana region (Biotechnical Educational Centre Ljubljana, General Upper Secondary School and Veterinary Technician School), where a project was launched in 2015 to further develop the knowledge on water. The project enabled students to expand their knowledge in various areas and acquire new skills at the same time.

General conditions for participation in the national competition are the ranking in the regional (local) competition and the maximum number of research projects (contributions/articles) from each region that can qualify for the national competition. This is determined on the basis of the average number of research papers in the regional competition in the previous three years, which is set each year in the announcement for the national competition of the current school year. The topics of the research papers are freely selectable. Current topics, also from the local environment, are recommended, especially in cooperation with the community, the business community or other interested parties, who can also announce the topics of the research papers via the Association for Technical Culture of Slovenia (ATCS). Participants must submit their research papers on time and in the form specified in the call for proposals for the respective school year. The research papers must be written in Slovenian and in a format that meets the current standards in the respective research fields. Foreign-language research papers that are reviewed by the main committee are exempt from the use of the Slovenian language. The use of a foreign language is permitted for such research papers. A foreign-language paper that does not deal with the use of a foreign language may be rejected by the committee. The papers are assessed by the members of the panel of experts responsible for the respective area. The panel is chaired by a chairperson. In the first round, the members of each expert panel review and evaluate the research papers that have qualified for the national competition and rank them according to points based on the criteria specified in the Call for Papers for the respective school year. During the presentation in the national competition, the members of the expert panel examine the independence of the candidate in the conception of the research project, the research approach, the methods and results, the systematics and significance of the presented material as well as the general knowledge (ATCS, n. d.).

At the end of the state competition, the participants receive awards and prizes depending on the results achieved. On the recommendation of the technical committees, the best-rated

projects are selected by the national committee to take part in international competitions for young researchers (ATCS, n. d.).

Our work involves qualitative and quantitative data analysis of research assignments conducted by secondary school students between 2010 and 2017. We focused on areas such as chemistry, biology and interdisciplinary fields. We invited former winners of the Association for Technical Culture of Slovenia (ATCS) who were secondary school young researchers to complete a questionnaire (ATCS, n. d.). Using a correlation analysis, we looked for a relationship between the chosen research area at the secondary school level and the choice of further studies at university level.

2. Methods and hypotheses

The survey (using a questionnaire (**Appendix**)) was completed by young researchers that were awarded the Gold Award for Young Scientists of Slovenia by ATCS during their previous education in the secondary school. The survey focused on competition in the fields of chemical and biological research projects as well as interdisciplinary scientific projects.

The questionnaire was created on the 1KA website (1 KA Enklik anketa, n. d.) and then distributed to the winners via social media (Facebook) and electronic messages using Gmail. After all respondents completed the questionnaire, we collected all data using the analytical tools via Microsoft Excel (Microsoft Corporation, version 2018). The collected data was then presented using pie charts created with the same programme.

Before the empirical part of the work, we established hypotheses that guided us throughout the study. We hypothesized that individuals who had a natural science focus of the project (chemistry, biology or interdisciplinary project) in the secondary school would also have a natural science focus in their further studies and profession. We hypothesized that the interdisciplinary subject will be most strongly represented among the respondents. As the research work was voluntary in most cases, we hypothesized that the students would not find it difficult, but on the contrary would enjoy it and were able to gain new experiences. We hypothesized that the majority would perform the research work again if they had the opportunity to do so.

2.1. Sample

Young researchers from secondary schools and grammar schools who received the ATCS Gold Award for secondary school students during their previous education between 2010 and 2017 were included. We were assisted by the organization ATCS, the main organizer of this competition. Some individuals of the researchers on our list of names were repeated and sometimes even tripled because they applied for and worked on the competition more than once during the observation period. We treated these researchers as one person who completed the questionnaire once. Of the 75 people invited, 35 successfully answered the questionnaire, some of whom are studying or working.

2.2. Instrument

We composed a questionnaire and sent it out via social media platforms (Facebook and Gmail). We opted for a closed questionnaire, which means that the respondent does not write the answer to the question, but selects one of the already prepared answers that seem the most appropriate. The questionnaire comprised a total of 14 questions, which were compiled in such a way that we could confirm or refute the hypotheses after the evaluation and find out the personal opinion of the respondents.

2.3. Statistical analysis

Pearson's chi-square (χ^2) is a basic statistical measure that compares observed and expected frequencies and evaluates how these frequencies differ. Larger values of Pearson's χ^2 indicate larger differences between the observed and expected frequencies. To interpret the results, the p-value was used, which represents the value and measures the probability that the observed difference between observed and expected frequencies is purely random if there is no real relationship between the variables. If the p-value is below

the selected significance level (usually 0.05), the null hypothesis is rejected and a statistically significant correlation is concluded.

The correlation analysis was carried out using the SPSS programme. We analysed correlations with the χ^2-test (hi-square) by using the programme IBM Corp. Released 2010, IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp., New York, USA. The results of the analysis (**Table 2**) were presented in various parameters. The degree of freedom (df) indicates the number of independent variables in the analysis. With the statistical programme SPSS, the output table contains a sig. value (2-tailed). Asymptotic p-values are useful for sample sizes where it is difficult to calculate an exact p-value. This value represents the 2-sided p-value of the test (Asympt. Sig. 2-sided p-value). It is roughly assumed that the sample size is large enough for the test statistic to converge to the corresponding marginal normal or chi-squared distribution. The p-value calculated using the approximate true distribution is called the asymptotic p-value (Analyse-it Software, n. d.). In general, the term association refers to coefficients that measure the strength of a relationship. The coefficients in this section are designed for use with nominal data. Phi and Cramer's V are based on adjusting chi-squared significance for sample size (approximate significance, Approx. Sig.). Phi is a chi-squared based measure of association. The chi-squared coefficient depends on the strength of the relationship and the sample size. Phi eliminates the sample size by dividing the chi-square by n, the sample size, and taking the square root. In purely mathematical terms, phi is the square root of chi-square divided by n, the sample size: phi = SQRT(χ2/n). Phi therefore measures the strength of the relationship, defined as the number of cases on one diagonal minus the number on the other diagonal, adjusted for the marginal distribution of the variables (Virginia Commonwealth University, n. d.). Cramer's V is the most popular of the chi-squared based measures of nominal association because it gives a good normalisation from 0 to 1 regardless of table size when the row edges are equal to the column edges. V is equal to the square root of the chi-square divided by the sample size n times m, i. e. the smaller of (rows–1) or (columns–1): V = SQRT(χ2/nm). SPSS and other important programmes indicate the significance level of the calculated V value (Virginia Commonwealth University, n. d.).

3. Results

With the first question of the questionnaire, we collected information about the gender of our participants. Of the 35 respondents, 24 identified themselves as male and 11 as female. The second question related to the respondents' current education, and it turned out that the largest percentage of respondents (77%) were natural science students. The smallest percentage of respondents were social science students (6%), and only a few of them (6%) were working on a secondary school degree. The third question related to the field of study in which the respondents were researching. One percent less than half of the respondents did research in an interdisciplinary field, and the rest did research in chemistry and chemical engineering or biology (**Figure 1**).

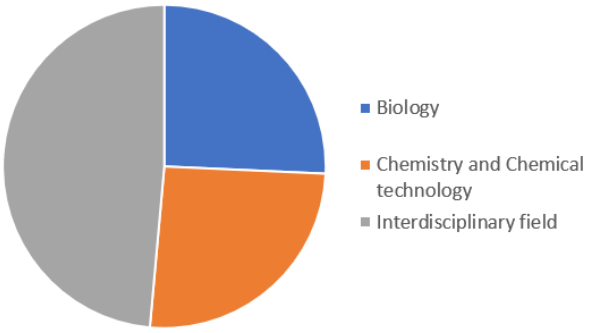

Figure 1. Choice of research area of the young people included in the sample. Distribution of choice within the natural sciences.

The fourth question, which was answered in the affirmative by 97% of respondents, was: "If you were a young researcher in secondary education, would you attend the young researchers competition again". With the fifth question, we wanted to find out whether the respondents thought that research is a good way to gain new knowledge, and we received the answer that they all agreed. The next question related to the selection or creation of the topic for the research paper and its elaboration. Of the 35 participants, 11 were without record of help (31%), 6 were supported by a school-based mentor (17%), 15 had help from an external mentor (43%) and 3 had received help from a school and an external mentor (9%). With the seventh question, we wanted to find out which part of the research the respondents enjoyed the most. Most (97%) found the practical part of the research work the most enjoyable, only one found the preparation of the written documentation the best. In the eighth question we asked about their impressions of the experimental part of the work and in the ninth question about their impressions of the written part of the work. When asked about the experimental part, 33 respondents chose the answer: *"I liked it, I was motivated and had fun"*. The same answer was given by 20 respondents to the ninth question. In the 9th question, the participants were asked for their opinion on the role of the mentors (school or external). Most (29 respondents) felt that the role of the mentor was important as it added value to the research and the candidate gained a lot from the research process; some felt that the role of the mentor was important but that the author of the research was responsible for everything, or that the role of the mentor was not important. The 10th question related to the current relationship with their mentor. The answers showed that more than half (60%) of the researchers have remained in contact with their mentor to this day. Regarding the 11th question: "Do you think your research has helped you develop other skills not related to the experimental part of the research (e. g. public speaking, overcoming stage fright, courage to stand by your results, personal growth, responsibility, etc.)?" 89% of respondents answered affirmative. In 12th question, we wanted to know if respondents were aware that research can help them in their future job search, and it turned out that 60% were aware of this fact (**Figure 2**).

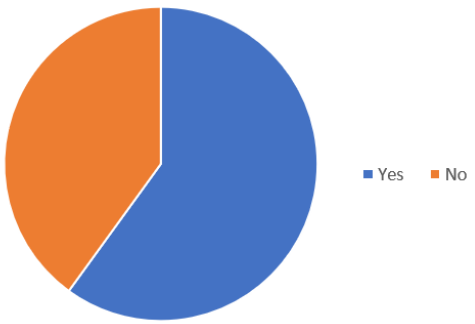

Figure 2. Question: Did you know that research can increase your chances of getting a job in the future?

In the 13th question, we asked the respondents whether the research work they had carried out had helped them in their choice of further education. More than half (54%) answered "yes", 8 individuals answered "no" and the same number of individuals did not specify ("I cannot define") (**Figure 3**).

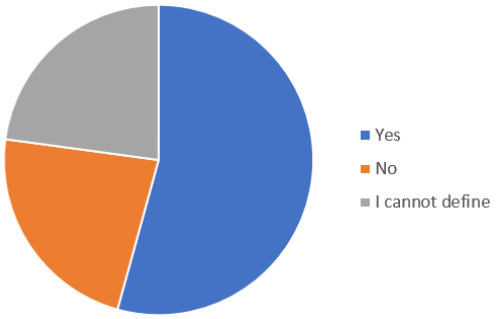

Figure 3. Question: Was the research helpful for your further choice of education (if you are a student) or employment or to establish yourself?

In the last (14th) question, we asked where the respondents see themselves in 10 years' time. 51% of respondents answered that they see themselves in the role of a researcher in public institutions (e. g. as a researcher at an institute or university), 23% in a company where they are involved in the development of products, 17% in a university, 9% as an independent entrepreneur and none in the role of a teacher or university professor.
Once collecting the data from the questionnaire, we also performed the correlation analysis (**Table 1**). The correlation of statistical differences we were interested in resulted from the second (2nd) and third (3rd) questions. We were interested in the statistical compatibility between the choice of subjects in secondary level and the later choice of educational or professional pathway.

Table 1. Corelation between responses to Question 2 and responses to Question 3.

			Question 3			
			Chemistry and chemical technology	Biology	Interdisciplinary field	Total
Question 2	Natural science student	Count	*0*	*1*	*3*	4
		Expected count	**1**	**1**	**2**	4
	Social sciences student	Count	*6*	*8*	*13*	27
		Expected count	**7**	**7**	**13**	27
	Employed in the natural sciences	Count	*1*	*0*	*1*	2
		Expected count	**0.5**	**0.5**	**1**	2
	Employed in the social sciences	Count	*2*	*0*	*0*	2
		Expected count	**0.5**	**0.5**	**1**	2
Total		Count	*9*	*9*	*17*	35
		Expected count	**9**	**9**	**17**	35

The bolded values indicate the correlation of mutually exclusive results (if the quantities were completely independent of each other) (*i. e.* there would be no correlation). The values in italic indicate the values determined by the crosstabulation.

Table 2. Correlations between the choice of research topic in secondary school and the subsequent choice of studies or employment (Q2 and Q3 questions) as calculated by Chi-square test.

	Value	df	Asymptotic significance (2-sided) (Significance test)
Pearson Chi-Quare	8.646	6	0.194
Likelihood ratio	9.659	6	0.140
Linear-by-linear association	5.633	1	0.018
Number of valid cases	35		

Symmetric measures		Value	Approximate significance
Nominal by nominal	Phi	0.497	0.194
	Cramer's V	0.351	0.194
Number of valid cases	35		

According to the results in **Table 2**, the p-value is greater than 0.05, which means that there is not enough evidence to reject the null hypothesis. This indicates that there is no statistically significant relationship between the choice of research topic (biology, chemistry and interdisciplinary field) and further education or employment path for our sample (further studies or career choice).

4. Discussion

We found that the completed research work helped the young researchers finding the path of their further career, which has at the time already taken shape. The young researchers were convinced that research is an excellent way to gain new knowledge. It is therefore of utmost importance that young individuals in primary and secondary schools are introduced to the research method for solving problems. The correlation analysis (χ^2-test) of the collected sample has shown that there is no statistically significant relationship between the chosen research field and the further educational or employment path. Our results indicate that the motivation of the individuals and their interest in any field of study are crucial. However, it should be borne in mind that the population comprised only 35 people and the lack of statistical significance could be due to an insufficient number of participants. The study will be continued.

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Appendix 1
Questionaire

1. Select your gender.
   a) Male
   b) Female

2. Please select your current level of education.
   a) Secondary school student.
   b) Student of natural sciences.
   c) Student of social sciences.
   d) Employed in the natural sciences.
   e) Employed in the social sciences.

3. What is your field of research? Please select the appropriate answer.
   a) Chemistry and chemical technology.
   b) Biology.
   c) Interdisciplinary field.

4. As a young researcher at a secondary school, would you take part in the Young Scientists Competition again?
   a) Yes.
   b) No.

5. Do you think that research is a good way to acquire new knowledge?
   a) Yes.
   b) No.

6. How did you choose or create the topic and the development of the research paper?
   a) I knew what I wanted to do, so I was completely independent.
   b) The topic and general development of the research paper was suggested to me by my school supervisor.
   c) The topic and general development of the research paper was suggested to me by an external mentor.
   d) The topic and the general development of the research paper was created jointly by the school and the external mentor.

7. Which phase of the research work did you like best?
   a) Carrying out the practical work.
   b) Preparing the written documentation.

8. What are your impressions of the experimental part of the research work?
   a) I enjoyed it, I was motivated and I enjoyed it.
   b) I did not care.
   c) The experimental work was superfluous, but I did it.
   d) I have unpleasant memories of the experimental work.

9. What are your impressions of the written part of the survey?
   a) I enjoyed it, I was motivated and I enjoyed it.
   b) It did not bother me.
   c) The writing was superfluous, but I did it.
   d) I have unpleasant memories of the written part.

10. In your opinion, what role does a (school or external) mentor play?
    a) Very important because the work has added value and the candidate benefits a lot from the research process.
    b) Important, but the author of the thesis is responsible for everything.
    c) Not important.
    d) I have never thought about that.

11. What is your current relationship with your supervisor?
    a) I have no contact with him/her.
    b) I respect him/her because he/she put me on the right path, but we do not see/hear each other often.
    c) I respect him/her because he/she put me on the right path, but we see/hear each other.

d) I am still in contact with him/her.

12. Do you feel that you have developed other skills through your research work that are not specifically related to experimental work (e. g. fluency, overcoming fears, standing up for your own results, personal development, responsibility, etc.)?
    a) Yes.
    b) No.
    c) I have never dealt with this specifically.
    d) I do not think research work involves other skills.

13. Were you aware that your research work could lead to future employment opportunities?
    a) Yes.
    b) No.

14. Did your research help you to choose a different course of study (if you are a student) or a job or to start your own business?
    c) Yes.
    a) No.
    b) I can not say.

15. Where do you see yourself in 10 years?
    a) In a career as a researcher or research professional.
    b) I will be working in a company where I can help develop products.
    c) I see myself as a teacher or professor encouraging young people to be creative.
    d) I see myself as a faculty member.
    e) As an independent entrepreneur.