Student attitudes towards astronomy: A bi-country questionnaire results

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This article presents the results of comparison of attitudes towards position of astronomy in education of students from two countries: Bosnia and Herzegovina and Croatia. A convenience sample of 396 third and fourth year high school students was surveyed using an anonymous self-report questionnaire. Students showed a certain indifference to pursuing a career in astronomy. However, both correlation and regression analysis indicated that students manifested a high degree of interest in acquiring knowledge, experience and skills in astronomy. This bi-country study shows that students' attitudes towards astronomy are similar considering the educational systems and position of astronomy in both Bosnia and Herzegovina and Croatia. The research results suggest that more students might consider astronomy for their scientific and professional career provided they had more opportunities for formal education in astronomy.

Keywords: History of astronomy; astronomy education; secondary school student attitudes; astronomy as a profession.

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1. Introduction

People of past and modern civilizations have been interested in finding answers about "all the structures we see around us" [1-3]. The questions about our universe have presented a challenge for many individuals and scientific communities, leading to the development of astronomy. Initially people were equipped only with their naked eyes to observe the universe and their minds to create explanations about the observed phenomena. Later, through centuries, the accumulated knowledge and the development of technology enabled the discovery of new scientific truths about the universe. Astronomy has roots in many other branches of science and mathematics and at the same time it integrates a series of scientific and cultural achievements of old and modern civilizations. Astronomy has a direct foundation in Physics, Chemistry, Biology, the Earth sciences, Mathematics, and Computer sciences. It has also been deeply involved in the development of civilizations where it has played a particular philosophical and social role.

Astronomy attracts both research community as well as the general public. On the one hand, it is a huge research field looking for answers to the questions that new generations will be facing in terms of energy sources and a deeper understanding of our universe for the betterment of humanity. On the other hand, as highlighted by European Association for Astronomy Education (EAAE) in Switzerland, "astronomy is extremely popular. There is a great public interest for topics such as eclipses, meteor showers, astronauts, and for all the popular magazines and TV programs about astronomy" [4].

Having such deep roots "in the history of almost every society and our culture" astronomy has an important role in education [5-7]. Astronomy could be an attractive playground where students can apply the knowledge gained in their science and mathematics classes [8]. Furthermore, inclusion of knowledge about the universe in education could have a positive effect on career decisions and encourage more students to take scientific careers. Research conducted by Spencer and Hubert [9] found that student attitudes towards the knowledge about space indicate that "space has humanitarian, global, environmental and enterprise dimensions, it crosses one spectrum from aero-space to astro-space, and another from ethical across to technological issues".

Astronomy education of children at a young age needs to be the main objective of new education strategies in countries where astronomy is not included in the curricula at elementary and secondary school level. Why is this important? The answer is very clear and simple: school children are the future initiators and protagonists of a new space age [10].

The most researched aspect of students' astronomy learning has been the conceptual understanding of astronomy [11-15], focused on three main concepts and models: the physical systems of different sizes, the behavior of light, and the uses of mathematics for scientific problem solving [16]. Several studies have shown that astronomy education realized during a longer learning process is a key factor in increasing positive students' and teachers' attitudes toward astronomy [17-20].

It is particularly important to emphasize the role of astronomy diagnostic tests (ADT) in astronomy education research [16,21-23]. The Project STAR Astronomy Concept Inventory was developed by Philip Sadler (1998) and designed to compare the effect of different instructions [16]. Michael Zeilik, with interdisciplinary team members, developed the first ADT, version 1.X, and used it in 1994 at the University of New Mexico [22-24]. It was a concept map test, attitudinal survey and an instrument for misconception measurements [22]. Based on the first ADT results, Zeilik and colleagues prepared a new ADT version. The ADT initial version 1.0 was developed in 1998 as a multiple-choice

research instrument which consisted of 33 questions [21,22]. Beth Hufnagel (2002) developed the ADT version 2.0 with 33-question pencil and paper multiple-choice survey for exploring the concepts in introductory astronomy learning, and tested the responses of a hundred students. The ATD version 2.0 was released in 1999 [25,26]. The survey includes 12 questions for recording students' attitudes. An extended ADT was introduced by Sadler and his five colleagues [23].

Students' prior beliefs about the nature of the Universe have an important role in improving astronomy education [27]. This is because these beliefs may often contain a series misconceptions and it is thus important for teachers to take these into account, because it "would seem that misconceptions need to be explicitly challenged in order for students to overcome them, in particular when these prior beliefs are deep-rooted in everyday experience" [27].

1.1. A bi-country overview on the position of science of astronomy

The UNESCO list of astronomical documents contains materials, maps, drawings, photographs, spectra, instruments, astronomical observatories, and many other forms that testify about the development of astronomy. These confirm the presence of astronomy in a society [28]. Another type of astronomical documentation are interpretations and theories based on physical laws of the universe. Bosnia and Herzegovina (BH) and the Republic of Croatia (Croatia) also possess a substantial body of documentation related to astronomy. Several Croatian scientists are widely known for their theoretical contributions (for example Roger Joseph Boscovich and Franjo Petrić), while in BH the existent astronomical documents indicate a prevalently practical nature of achievements in the field of astronomy.

In neither Croatia nor BH there has been research conducted in the field of astronomy teaching since astronomy is taught only at the level of informal education. Consequently, there has not been research on students' attitudes about astronomy which leaves us with no insight into what students think and whether they have developed an understanding of the basic concepts in astronomy. Therefore, the present study is the first to investigate this issue and the data are disaggregated by sex, nationality, and grade.

1.1.1. Position of astronomy in Bosnia and Herzegovina

Astronomy does not have a deeper relevance in the educational system of Bosnia and Herzegovina (BH). The first documented astronomical knowledge on the BH territory dates back to the end of the 15th century, and coincides with the time of the Ottoman Empire. In the beginning, educated professionals from the Empire taught astronomy to Bosnian students, scholars and professionals by showing them not only how to use astronomical instruments and timekeeping techniques, but also the basic principles and postulates in astronomy and mathematics. Astronomical knowledge was easily applied to emerging religious needs so it proved to be useful for the population that lived on the territory of BH. For example, professionals skilled in mathematics and astronomy were primarily needed for timekeeping by scientific method rooted in astronomy and other activities such as construction of calendars or determination of the sacred direction to Mecca during prayer. The main sources for learning about astronomy until the end of the 19^{th} century were collections of oriental manuscripts which were mainly transcribed astronomical works by prominent astronomers from the golden era of Islamic civilization between the 11^{th} and 15^{th} century. In addition, astronomic tables, calendars, descriptions of astronomic instruments and instruction manuals for astronomic instruments were also part of astronomic manuscript collections used as educational materials. It was up to the early 20^{th} century that the educational systems on the territory of Bosnia and Herzegovina had included astronomy as an elective subject in schools or as a kind of informal education for practicing astronomers who had been involved in timekeeping activities [29].

Amateur astronomy research in BH was established 50 years ago through a university astronomical society which worked in continuity until 1992. Members of this amateur organization were involved in active celestial object observation, mostly asteroids, and they collected data using modern technologies of the time, situated in the astronomical observatory located on the top of Mount Trebević, close to the city of Sarajevo (capital of BH). The only astronomical observatory in BH was completely destroyed during the 1992-1995 war, and after 24 years has not yet been rebuilt. Astronomy, as a school subject, is not represented in either primary or secondary school curricula in Bosnia and Herzegovina. In particular, it should be pointed out that in the last twenty years, astronomy has never been included in the originally created primary and secondary school curricula, and is only integrated in university science curricula, including one or two introductory courses in astronomy at the undergraduate level.

Young people in BH can join four amateur astronomy clubs today: one in Sarajevo (*Orion*) that preserves activities of the former university astronomy club tradition, and three newly established clubs (*University Astronomy Club* in Banja Luka, *The Pleiades* in Tuzla and *Astra* in Zenica). None of the clubs' members have a degree in astronomy. On the other hand several Bosnian contemporary astronomers were educated abroad and have not returned. Today, in BH there is no astronomical observatory, where even amateurs or science students could observe and collect data about the universe. The aforementioned astronomy clubs have organized several astronomy schools and a number of events such as public night sky observations.

1.1.2. Position of astronomy in Croatia

In Croatia, astronomy has an approximately five-century long tradition which has generated several well-known scientists.

Astronomy as a subject of research and education was the focus of several widely known Croatian philosophers, physicists, mathematicians, and astronomers. The most well-known Croatian scientists in general and particularly in astronomy were: Hermanus Dalmata who studied astronomy in Spain around 1140, Frederik Grisogono (1472-1538), Franjo Petrić known as Franciscus Patricius (1529-1597), Stjepan Gradić widely known by his name Stephanus Gradius (1613-1683), and Roger Joseph Boscovich (1711-1787), a well know scientist all over Europe.

The first modern observatory (Marine Observatory) in Croatia was established in Pula in 1871, on the hill of Monte Zaro. At one time, it was the largest observatory in the Austro-Hungarian Empire. Up to the mid-twentieth century, astronomy was taught in school, but after the break from the Empire it lost its significance in the educational system. However, removing astronomy from the educational curriculum did not mean the loss of interest in astronomy. Indeed, several astronomical societies were established in Croatia and had a significant educational and scientific role. Formal astronomy education in Croatia is very similar to the situation in BH today. There are, however, a few significant differences between the two countries in terms of the position of astronomy in the country itself. Firstly, Croatian scientists have engaged in various research studies of the universe such as heliographic research and astrophysics research. In Croatia, there are four prominent astronomical observatories available for scientific research and numerous activities on astronomy education: Zagreb Astronomical Observatory, founded in 1903; Hvar Astronomical Observatory (Hvar is an Adriatic island city), founded in 1972; Rijeka Astronomical observatory, a new astronomical center consisting of astronomical observatory and planetarium, opened in 2001; and Višnjan Astronomical Observatory (located in the Istria Peninsula region), founded in the seventies, and equipped in years 1977-2002 for doing mostly asteroid research and astronomy education within the network of 19 centers in the world. Secondly, an important difference between BH and Croatian astronomy are the informal education possibilities reflected in significant number of astronomical societies and clubs which are popular with young people (more than 30 in various cities such as Zagreb, Split, Rijeka,Virovitica, Zadar, Koprivnica, Kutina, etc.). In Split, where this research was conducted, the three astronomical societies are very active, and in the vicinity of Split there is an astronomical observatory (located on the Mosor hill).

The third very important difference between the position of astronomy in Croatia and BH are possibilities for participating in astronomy competitions. In BH, there are no students' competitions in astronomy knowledge and skills, but in Croatia astronomy competitions are organized every academic year at school, regional, and state level, but also at international level, all under the administration of Croatian governmental institutions. Such competitions have been organized since 2001 with around 100 students per year participating at the final state level competition. The best out of this group are selected to participate in international astronomy competitions.

2. Research problem

The main aim was to research what high school students think about astronomy in terms of their interest in this domain and the influence on their career choices. At the same time we wanted to find out about students' opinions about astronomy as either an obligatory or an elective subject. Students' interest will be investigated by eliciting the attitudes of students from Bosnia and Herzegovina and Croatia about the position of astronomy in their educational systems.

The study is trying to answer the following research questions:

> RQ1: *Do the research participants from Bosnia and Herzegovina and Croatia think astronomy should be included as an obligatory or elective subject in secondary school?*
>
> RQ2: *Which category of the astronomy attitude questionnaire has the most powerful potential to influence students' career choice in astronomy?*

This is the first time for this type of study, involving BH and Croatian students, to be carried out in both countries.

2.1. Research methodology

2.1.1. Attitudes Instrument-Questionnaire for determining students' attitudes towards astronomy

Questionnaire for determining students' attitudes towards astronomy is an instrument designed to meet the needs of this research since the relevant literature and the scientific bases currently do not provide a similar one. It was designed following the examples of renowned questionnaires used for analyzing students' beliefs and expectations in physics: Maryland Physics Expectation Survey (MPEX) [30], Views About Science Survey (VASS) [31] and Epistemological Beliefs Assessment about Physical Science (EBAPS) [32]. A particularly important research instrument that informed the design of our Questionnaire is the CLASS test (Colorado Learning Attitudes about Science Survey) [33,34].

The first part of the questionnaire provides students' background data such as: gender, age, and the grade they are in. The second part of the questionnaire is related to the attitudes toward astronomy and consists of 16 statements divided into four categories (Table I see its *Categories and statements* column). The name attached to each category is only a term and not a summary of the statements contained in the category (*i.e.* the name does not define the beliefs contained within the categories).

The first category, "Interest", consists of 6 statements that assessed students' interest in astronomy and related topics and the influence exercised by the primary and secondary

school curriculum. The second category, "Experience", consists of 4 statements assessing students' experience with asastronomy so far. The third category, "Skills", consists of 4 statements assessing students' specific practical skills in night sky observation and use of astronomical instruments. The fourth category, "Career", consists of 2 statements assessing students' attitude towards pursuing an academic career in astronomy. The answers were presented on a 5-point Likert scale:

- I strongly disagree (graded as "1");
- I disagree (graded as "2");
- Neutral (graded as "3");
- I agree (graded as "4") and
- I strongly agree (graded as "5").

The negative attitude is expressed by both 1 "I strongly disagree" and 2 "I disagree". The positive attitude is expressed by both 4 "I agree" and 5 "I strongly agree".

2.1.2. Research Sample

The research was carried out in the academic year 2013./2014. The respondents from both countries come from one school only in each of the countries. All BH respondents (from Sarajevo city) and Croatia respondents (from Split city) were high school students. This type of high school in both countries is known under its name gimnazija (grammar school, gymnasium).

A convenience sample of 396 third and fourth year secondary school students was surveyed using an anonymous self-report questionnaire. There were 196 (49%) students from Sarajevo, Bosnia and Herzegovina, and 200 (51%) students from Split, Croatia. The questionnaires were completed by 241 (61%) female respondents and 155 (39%) male respondents. Mean age of third grade students was 16.8 years and mean age of fourth grade students was 18.1 years.

Although the students under research had never been taught astronomy as a school subject, they did have some knowledge about astronomy gained through physics and geography classes or from various extracurricular activities and resources. None of the students were members of an astronomy club or astronomical society.

The selected schools are typical of all other schools with a general programe of high education both in BH and Croatia. It is a four-year programe with an equal attention dedicated to natural sciences and mathematics.

The high school curriculum in BH and Croatia are very similar. The respondents completed an 8-year-long elementary school programe, and a 4-year-long high school programe. In BH and Croatia, in elementary school physics and geography the students get an idea of the position of astronomy in total science and basic concepts on astronomy. At the same time, the distinction between astronomy, astrology and the science of space research is emphasized. That is why we believe that respondents could not be confused with what was meant by astronomy. This is also supported by the fact that the survey was conducted in the context of physics classes.

In both schools the research was conducted in physics classes. It should be noted that all third and fourth grade students were involved in the research without a particular selection procedure being applied. All students who participated in the research voluntarily filled out the questionnaire. In Sarajevo one of the authors (Z.H.) ZH was responsible for the implementation of the questionnaire by BH high school students but did not participate in their teaching, while in Split the researcher (M.M.) was also the respondents' physics teacher.

Currently in both countries more girls than boys enrol in grammar schools and this is, therefore, reflected in the gender balance of our respondents (61% girls and 39% boys). We opted for the students attending the last two years of their secondary education with the assumption that they would have the experience of both elementary and secondary education and thus be better equipped to critically examine the education system.

2.1.3. Composite Score

A composite score was created for each category to evaluate the students' opinions. The score was calculated as the sum of all the answer scores on each category. The minimum score of the category is the one where all the statements of the category are graded as 1 (strongly disagree); the neutral score is the one where all the statements of the category are graded as 3 (neutral) while the maximum score is the one where all statements are grades as 5 (strongly agree). The maximum score in the category "Interest" was 30, neutral score is 18 and the minimum is 6. The higher score indicated more general interest in astronomy. The maximum score in the category "Experience" and "Skills" was 20, neutral score is 12 and the minimum was 4. The category "Career" had the maximum score of 10, neutral score is 6 and minimum score of 2. The higher score indicated a higher chance to be interested in pursuing an academic career in astronomy.

2.1.4. Data Analysis

The normality of data distribution was tested using the Shapiro-Wilk test. Since the distribution was not normal, the Mann-Whitney test was used to determine the differences in scores on each category between groups of students defined by country, sex and grade. Spearman's rho was used to test the association between all category scores in each category. Linear regression was used to assess the relevance of significant correlations between important categories. The level of statistical significance was set at 0.05. All statistical analyses were performed with SPSS Version 19.0.0.

3. Results

The attitudes of third and fourth grade high school students in Bosnia and Herzegovina and Croatia towards astronomy presented as answers to 16 statements broken down into 4 categories are given in Table I.

The median student score on the "Interest" category was 18 (range 23, neutral score 18), with almost 40% of students who were indecisive about the statement "my interest in astronomy is great". However, more than half of the students thought that astronomy was an interesting field, but should be an elective, rather than an obligatory subject. Fourth grade students scored significantly higher than third grade students in this category (Table II).

The median student scores on the "Experience" and "Skills" categories was 7 and 9, respectively (both with range 16 and neutral score 12), with almost three quarters of students answering "strongly disagree" or "partially disagree" to most of the questions regarding experiences in astronomy education, or astronomy skills. BH students scored significantly higher on the "Experience" category, whereas Croatian students scored higher on the "Skills" category (Table II).

The lowest scores were achieved on the "Career" category, with median student score being 3 (range 8, neutral score 6). BH students showed higher scores than Croatian students. However, this difference did not reach statistical significance, probably because of abnormal data distribution and low scores with low ranges in this category.

Analysis of differences in achieved scores in categories between BH and Croatian students regarding gender and grade showed no significant differences between male and female students. BH fourth graders had higher scores in the "Interest" and "Experience" categories than the third graders, whereas Croatian fourth graders scored higher than the third graders in the "Interest" category (Table III).

TABLE I. The attitudes of third and fourth grade secondary school students from Bosnia and Herzegovina and Croatia towards astronomy.

Categories and statements	No. (%) of students with answer		
	Negative attitude	Neutral attitude	Positive attitude
Interest			
1. I am highly interested in astronomy.	118 (30)	154 (39)	124 (31)
2. My interest in astronomy is associated with the school subjects that I have learnt at school.	271 (68)	79 (20)	46 (12)
3. Astronomy is an interesting field.	61 (15)	111 (28)	224 (57)
4. I would like to learn astronomy as an obligatory school subject.	175 (44)	113 (29)	108 (27)
5. I would like to learn astronomy as an elective school subject.	78 (20)	80 (20)	238 (60)
6. If an astronomy course was organized in my school I would like to attend it.	116 (29)	118 (30)	162 (41)
Experience			
1. I have learned astronomy individually using astronomy textbooks that were available to me in bookstores.	267 (67)	93 (24)	36 (9)
2. I have learned astronomy individually using astronomy learning materials from various websites.	187 (47)	78 (20)	131 (33)
3. I learned astronomy using astronomy learning materials individually while I was attending seminars organized by my school.	344 (87)	37 (9)	15 (4)
4. I learned astronomy using astronomy learning material individually while I was attending seminars organized outside of my school.	335 (85)	41 (10)	20 (5)
Skills			
1. If I observe the night sky during clear nights, I can differentiate the stars or planets in the solar system.	173 (44)	89 (22)	134 (34)
2. I own a telescope to observe objects in the sky at night.	330 (84)	29 (7)	37 (9)
3. I visited an astronomical observatory at least once.	220 (56)	21 (5)	155 (39)
4. I am very good at using astronomy simulations of the night sky (software).	313 (79)	42 (11)	41 (10)
Career			
1. I have considered studying astronomy because it attracted me to learn more about the universe and the world's future.	293 (74)	68 (17)	35 (9)
2. I have considered studying astronomy because astronomy is a challenge for me.	265 (67)	78 (20)	53 (13)

TABLE II. Differences in composite categories' scores among students defined by country, sex, and grade in secondary school.

Category	Composite scores: median (range)						
	Total	Country		Sex		Grade	
		BH	Croatia	Male	Female	Third	Fourth
Interest	18 (23)	19 (23)	18 (22)	18 (23)	19 (23)	18 (21)	19 (23)*
Experience	7 (16)	8 (16)†	7 (12)	8 (16)	7 (12)	7 (12)	8 (16)
Skills	9 (16)	7 (16)	10 (14)‡	9 (16)	9 (14)	9 (14)	9 (16)
Career	3 (8)	4 (8)	2 (7)	2 (8)	3 (8)	3 (8)	3 (8)

*Significantly higher score than third grade students, Mann-Whitney test, $p < 0.05$.

†Significantly higher score than Croatian students, Mann-Whitney test, $p < 0.05$.

‡ Significantly higher score than BH students, Mann-Whitney test, $p < 0.05$.

TABLE III. Differences in composite categories' scores between BH and Croatian students disaggregated by sex and grade in secondary school.

Category	Composite scores: median (range)							
	BH				Croatia			
	Sex		Grade		Sex		Grade	
	Male	Female	Third	Fourth	Male	Female	Third	Fourth
Interest	19 (23)	19 (20)	17 (20)	19 (23)*	18 (18)	18 (22)	18 (18)	19 (21)*
Experience	8 (16)	8 (16)	8 (10)	9 (16)*	7 (9)	6 (12)	6 (12)	7(11)
Skills	7 (16)	7 (14)	6 (11)	7 (16)	10 (14)	10 (13)	10 (14)	10 (13)
Career	3 (8)	4 (8)	3.5 (8)	4 (8)	2 (6)	2 (7)	2 (7)	2.5(6)

*Significantly higher score than third grade, Mann-Whitney test, $p < 0.05$.

The category "Career" showed significant positive correlation with the "Interest", "Experience" and "Skills" categories (Spearman's rho, $p < 0.001$, Correlation coefficients 0.496, 0.428, and 0.284 respectively). Because of the significant positive correlations of all observed categories, linear regression analysis was performed in order to detect the strongest relationships between significantly correlated category scores. Linear regression analysis with the category "Career" as dependent variable showed strongest relationship with the category "Interest" (R square 0.227), whereas categories "Experience" and "Skills" were less strongly related to the "Career" category (R square 0.171 and 0.082, respectively) (see Fig. 1-3).

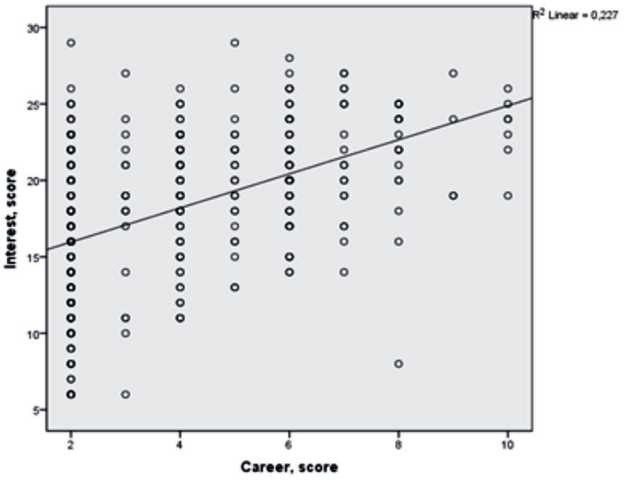

FIGURE 1. Relationship of the "Career" category score with the "Interest" category score analyzed with linear regression.

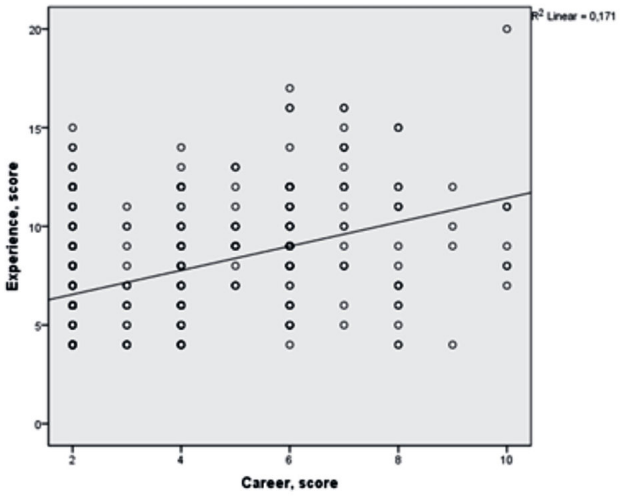

FIGURE 2. Relationship of the "Career" category score with the "Experience" category score analyzed with linear regression.

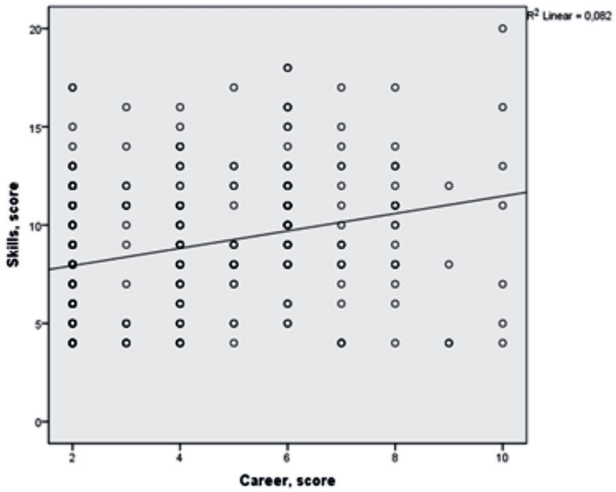

FIGURE 3. Relationship of the "Career" category score with the "Skills" category score analyzed with linear regression.

4. Discussion

Students who participated in the study have shown interest in learning astronomy although they did not have it as a school subject in either primary or high school curricula. The results showed that the students did not possess enough experience and skills in astronomy acquired either in formal, in informal or individual learning. Students demonstrated that they were not interested in building careers in astronomy (it had the lowest score of all categories, and it was close to the theoretical minimum in the category). Such a situation is typical for both groups of students, but only female students from Bosnia and Herzegovina showed a little more interest in astronomy as their career choices, but the result did not prove to be significant. This study showed that the students' positive attitudes towards astronomy are more strongly related to their interest than to their experience, skills, and career choices. Correlation and regression analysis indicated that, apart from the interest, the students also manifested a high level of awareness of the skill and experience necessary for the career of astronomer. Provided these skills are taught and practiced in formal education the students might be more attracted to a career in astronomy.

Answer to RQ1 is more affirmative for astronomy as elective school subject (60% of students vs. 27% of students who considered that astronomy needs to be included as obligatory learning subject (see Table I). There were a number of students who showed neutral attitudes for both astronomy as obligatory (29% of students) and astronomy as elective (20% of students) school subject (see Table I). The second research question (RQ2) showed that students' "Interest" is the most relevant factor when thinking about a career in astronomy, compared to other category items. This is illustrated by the linear regression analysis where the category "Career" as dependent variable showed strongest relationship with the category "Interest" (R square 0.227).

It is interesting to note that BH students achieved better results in the "Experience" category, while Croatian students achieved better results in the "Skills" category. These results can be explained by the real circumstances of the country in which the survey was conducted. As explained in the introductory section, there is a significant difference in the accessibility of observatories in the two countries. There are currently no functional observatories in BH, while there is a significant number of active ones in Croatia, one of them situated in the vicinity of the city of Split, where research was conducted. Very often, in elementary and high school education in Split (Croatia), trips to the observatory are organized in cooperation with astronomical societies. These astronomical societies also offer informal astronomical education most often realized in form of observation of the sky. Thus better results of Croatian students were found in the "Skills" category.

On the other hand, in BH, due to the lack of access to direct observations in an observatory, students are more oriented towards other sources of knowledge: astronomical textbooks, web pages, in-house and out-of-school seminars. Although the Croatian students have access to the same kind of sources their interest in astronomy is obviously met by visits to an observatory or by making use of a personal telescope. In both countries, fourth grade students show a significantly higher interest in astronomy than third grade students. This result indicates that senior grammar school students are considering the position of astronomy in their education at the same time when they are taking philosophy classes and classes in modern physics. It is highly likely that the kind of formal teaching they are undergoing at the moment encourages them to seek a complete picture of the world that is manifested through an increased interest in astronomy.

For both groups of students, attitudes towards building a career in astronomy were closer to negative than positive. We have found through linear regression analysis with the category "Career" as dependent variable that the relationship with the category "Interest" is strongest, whereas categories "Experience" and "Skills" were less strongly related to the "Career" category.

The focus of this study was the interest of students in astronomy as a career, but it is likewise very important to explore students' interest in astronomy as a hobby. Although this was not the goal of this study, it should be emphasized that encouraging the idea of taking up astronomy as a hobby would be extremely important for an increase of general astronomical knowledge in the population. Accordingly, our data indicate 31% of students are interested in astronomy, and 57% of students think astronomy is an interesting subject. This kind of interest, accompanied with the right incentive, might lead to these students becoming amateur astronomers.

5. Conclusion

This bi-country study shows that students' attitudes towards astronomy are similar which is not surprising considering the

similarity of the educational systems and position of astronomy in both Bosnia and Herzegovina and Croatia. The main similarity lies in the fact that the students do not learn astronomy as part of the national curriculum at any of the three levels of education. In other ways the situation in Bosnia and Herzegovina is different from that in Croatia in terms of cultural frameworks. In Bosnia and Herzegovina some professionals had been involved in practical astronomy because of timekeeping rooted in its culture. On the Croatian side there were several scientists involved in theoretical astronomy. Today, in Croatia there are a number of astronomical observatories and scientists doing research, but this is not the case in Bosnia and Herzegovina. Informal astronomy education is stronger in Croatia than in Bosnia and Herzegovina in terms of the number of astronomical societies and astronomy clubs where young people can learn about astronomy and be drawn deeper into it. Circumstances in the two countries are different, but students showed almost the same attitudes related to their interest in astronomy in general and astronomy as a potential career choice.

The didactical suggestion verified in the study can be an inspiration for authorities from both countries to find a way to develop an astronomy curriculum and to support educational institutions to include it in formal education at all levels as an optional school subject or course. It could be an opportunity for establishing widespread educational standards in science education.

On the other hand, science teachers are advised to design some effective projects to include astronomy into practice at school as after-school activities. Science teachers and schools should include the extra-curricular astronomy lessons to make students' achievements greater in the context of the four categories researched by the questionnaire. In this way, the number of professionals in science of astronomy and astronomy education could potentially be increased in both Bosnia and Herzegovina and Croatia. In order to guarantee future implementation of astronomy education in Bosnia and Herzegovina and Croatia teachers (especially science teachers) need to develop positive attitudes towards astronomy and they need to be adequately trained in order to be able to transfer the knowledge and enthusiasm to the new generations. To facilitate this, they can be encouraged to participate in in-service training programs, and to cooperate with astronomical societies and observatories. At the same time, it might be an opportunity to increase young people for interesting on astronomy as an attractive hobby.

Do students need to have opportunities within the curriculum to study exotic objects such as far-away galaxies, black holes, white dwarf stars, or binary stars by calculating their properties, and then comparing these to experimental observation data? The answer would be affirmative for every student as well as for students from both Bosnia and Herzegovina and Croatia.

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