

# The relationship of students' attitudes to technology and their creative ability

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**ABSTRACT:** While creativity, innovation and technological competencies are among the top priorities for a 21st Century economy, many contemporary views of education deemphasise both the development of creativity and attitudes to technology. The purpose of this research was to present a relationship between students' attitude to technology, and their creative ability, since creativity only happens when interests and abilities coincide. For this study, an effective sample of 415 students aged 12-15 years was collected. The results revealed that students' attitudes to technology were under average, while their creative potential was estimated to be low. Perceived consequences of technology seem to be a crucial predictor of the creative potential of students. To enhance both students' creative potential and attitudes to technology, rather than teach domain knowledge, the foci should be on managing in the modern technological world and understanding why they need to be able to improve their life-world through exploratory production activities.

## INTRODUCTION

In the world, the number of problems is growing rapidly, and their complexity is increasing. For that reason, one needs problem solvers to help to improve [1] and sustain the living environment [2]. The authors can say that technological knowledge itself is not enough to solve rapidly changing world problems. To cope with technology needs an inclusion of effective, cognitive and meta-cognitive domain is required [3][4]. Technology is now more present and attitude to technology plays an important role [5].

Students' attitudes seem to appear to be key mediator in the learning process [6], where subject matter knowledge, pedagogical content knowledge and attitude to, and perceptions of, technology have positive effects on students' learning outcomes [7]. The advancement of technology has changed human values, desires and ways of working [8]. Today, problems arise that require some measure of ingenuity, imagination and creativity [9][10]. Technology education prepares students to understand and participate in a technological society [11]. Involving students in technology education could improve their perception to technology [4].

Students' attitudes are important concepts to understand their thoughts, processes and practice in the classroom. There are many definitions of multidimensional concept attitude [12], but in general, attitude is defined as an internal, personal, psychological tendency to evaluate an object or construct in a positive or negative manner [13]. It could also be an individual's opinion about characteristics of a particular subject [14].

Many researchers proved the importance of technology education, but peoples' view of technology and technology professions is negative [5]. Young people are interested in technological products, but their opinion on technological education and technological professions is negative. Many believe that learning technology is difficult and boring, the industrial environment is uninteresting, and the work is difficult and dirty [4].

De Vries defined five categories of attitude to technology, including interest in technology, aspirations for a technological career, perceived consequences of technology, perceived difficulty of technology and the student's perception of technology as a subject suitable to both genders [5]. The attitude can be influenced by many characteristics: sex, age, the presence of technological toys and the environment. More research of attitudes about technology have found that female students have an under average attitude to technological study or profession [3][12][15].

Female students see technology and science as difficult subject matter. Female students' interest for technology declines after the age of 10. Technological toys also have a positive impact on their attitude to technology, because they stimulate the tendency towards a technological profession. Parents are also an important factor. Students whose parents

are related to technological professions are more interested in technology. It has been proven that female and male students prefer to decide on a technology profession, if their mother is in a technology profession [3]. Another important factor in building a positive attitude to design and technology are teachers. Teachers, who perceive technology as being boring, are less aware of this and are not able to stimulate the students' attitudes [6][13][16]. Comparison of four different European countries (Finland, Slovenia, Estonia and Iceland) in students' attitudes to technology revealed that female Slovenian students have the lowest attitude to technology and interest in the technology profession [15].

Creativity is one of the key competencies of the 21st Century [9]. Scientists in the field of education believe that society needs creative individuals to survive. They are convinced that reproduction and routine thinking are not enough in a rapidly changing world. Life has changed a lot in recent years. Schools are no longer able to teach students all the practical skills that they would need for life, because it is not possible to know, which skills will be needed in the future. Teachers should ensure that students are equipped with flexible skills and abilities. Society needs inventive, flexible and adaptable adults [17].

Creativity plays an important role in many technology and engineering curricula, because it fosters students' inventiveness [18]. In the literature, there are several definitions of creativity. Generally, one can define creativity as the generation of new ideas or new ways of looking at existing problems and seeing new opportunities [19]. Similarly, technical creativity is a degree of novelty, originality and usability [20]. On the other hand, Cropley defined technical creativity as creation of technical solutions for given problems [21]. Creativity is an ability that can be learned. Teachers should use active learning methods, a student-centred teaching approach and collaborative activities. The role of the teacher is to be an instructor or guide, certainly not an expert [9][20][22].

In technology or engineering education, the problem-based learning method or creative problem-based learning method is most often used [23]. Avsec et al emphasised the influence of social factors, intrinsic motivation, content-relevant knowledge and the ability to create and active learning [16]. Benson and Lunt conducted a study among students aged between 9 and 11 years on how much creativity was encouraged in the subject of technology [24]. They found that although students are highly motivated in technology, teachers with learning strategies do not promote creativity.

For creativity, they emphasise the importance of motivation, control over knowledge, ideas, abilities, time, space and interaction with peers or teachers. Wong and Siu conducted a survey in Hong Kong and found that nobody encouraged creativity when reviewing projects carried out in technology [25]. Pupils were limited in generating ideas and were not encouraged to explore. The main purpose of the projects was to acquire knowledge and skills.

Creativity can be developed within technology education subjects. Creativity is an integral part of design. What designers do, corresponds with the nature of creativity. An integral part of design is to solve problems in a new and creative way [26][27]. The design process in design and technology subject matter relies on the development of novel, useful and appropriate ideas [25]. Design and technology is a subject in which students should create, plan and produce new products [28].

In Slovenia, a design and technology subject is a compulsory secondary school subject in the sixth, seventh and eighth grades. The subject curriculum specifies that students should discover and understand simple technical and technological problems using simple tools. Students should creatively connect natural science and technical knowledge and develop abilities and creativity. The general objectives of the subject assume that students learn, research, experiment, analyse and create. The curriculum recommends the use of experiential, problem and project-based learning to ensure students' active work.

Nevertheless, the focus of the students in the design and technology subject is still too much on the teacher, limited by textbooks and kits with semi-prepared materials. An important role in this is also a motivation of students, which differs from student to student. The general aims of the design and technology subject state that students should develop a positive and critical attitude to technology. The design and technology subject should also develop the interests of students in a professional direction.

Šorgo argued that creativity does not start at the university or on the first day of employment, and that creativity should be fostered through the compulsory levels of education (e.g. at primary and secondary school) [29]. After revision of textbooks, he concludes that they do not allow creativity in science. Research shows that excessive involvement of teachers, students' limitations with textbooks, excessive control of students, and a lack of active and cooperative learning do not encourage creativity. Motivation, ways of teaching and learning, technological knowledge and skills, ability for problem-solving are factors, which might influence the development of technical creativity.

Research questions explored in this study are:

- What is the level of students' attitude to technology?
- What are the differences in sixth- to ninth-graders' creative potential?
- Do students' attitudes to technology predict their creative ability?

## METHOD

### Sample

The sample in this study comprised 415 secondary students aged 12-15 from eight Slovenian schools. The gender distribution was almost even: 48 % female and 52 % male.

### Instruments

For surveying students' attitude toward technology, a reconstructed 25-item test of *Pupils' Attitude to Technology* [5] was used. The survey included 10 demographic questions. Demographic questions covered sex, age, family background and home education background. The instrument developed in its Slovene version had six constructs: 1) technological career aspirations (TCA) - 4 item; 2) interest in technology (IT) - 6 items; 3) tediousness to technology (TTT) - 4 items; 4) technology across the sex (TS) - 3 items; 5) consequences of technology (CT) - 4 items; and 6) technology difficulty (TD) - 4 items. For the assessment, a 5-point Likert scale was used. The intervals of the scale together form a continuous type, from 1 (very unlikely) to 5 (very likely). The Cronbach's alpha values, calculated based on the samples of this study, indicated the developed instruments is reliable (Table 1), all Cronbach's alpha values are > 0.60.

Table 1: Reliability information expressed with Cronbach's  $\alpha$  *Technology and Me* survey subscales.

Subscales	TCA	IT	TTT	TS	CT	TD
Cronbach $\alpha$	0.90	0.76	0.80	0.90	0.78	0.63

The creativity of students was surveyed with the standardised test of creative *Thinking-Drawing Production* (TCT-DP) [30]. Students complete incomplete drawings in any way they like. For the assessment, fourteen criteria were used [30][31]. The maximum score on the test was 72 points. The authors also provide evidence of reliability of the TCT-DP test with Cronbach's  $\alpha = 0.67$ .

### Data Collection and Analysis

Study was performed in May and June in the 2016/2017 study year. Students were surveyed using a paper and pencil method. Both tests were performed once only. Individual testing for each test took 10-15 minutes. Administration of the *Technology and Me* survey was performed when the creativity test had been completed. The data were analysed using IBM SPSS (v.22). To support the reliability of the tests, a Cronbach's alpha coefficient was used. Besides this, the basic tools of descriptive statistics, *t*-test, one-way ANOVA, and multiple regression analysis were used.

## RESULTS

### Students' Attitudes to Design and Technology

Table 2 shows that in general, students have a low interest in technology professions, but they have an interest in technology. Students have also the opinion that technology is not boring. In addition, they are aware of the consequences of the importance and the usefulness of technology.

Table 2: Students' average rating on attitude to technology on survey's subscale.

Subscales	TCA	IT	TTT	TS	CT	TD
<i>M</i>	2.28	3.17	2.15	2.99	3.59	2.47
<i>SD</i>	1.07	0.95	0.94	1.40	0.89	0.84

An approximate *t*-test for an independent sample between male and female students showed statistically significant differences in the TCA category ( $t = -7.369$ ;  $df = 386$ ;  $p = 0.000$ ). Male students are more concerned with the technological profession ( $M = 2.63$ ;  $SD = 1.16$ ) than female students ( $M = 1.91$ ;  $SD = 0.82$ ). The *t*-test also showed statistically significant differences between male and female students in the IT ( $t = -5.547$ ;  $df = 413$ ;  $\alpha = 0.000$ ), and TTT ( $t = 4.944$ ;  $df = 413$ ;  $p = 0.000$ ) and TS ( $t = -7.585$ ;  $df = 413$ ;  $p = 0.000$ ) categories. One can see that male students generally have more interest in the technical profession and technology. On the other hand, the field of technology is boring to female students. Male students are also convinced that technology and engineering is only for men.

One-way ANOVA tests showed statistically significant differences between the sixth, seventh, eighth and ninth grades in the categories TTT ( $F = 3.808$ ;  $df = 3$ ;  $\alpha = 0.010$ ), TS ( $F = 8.152$ ;  $df = 3$ ;  $p = 0.000$ ), and TD ( $F = 6.666$ ;  $df = 3$ ;  $p = 0.000$ ). Figure 3 shows students' average rating of attitude to technology across classes on each subscale of attitude to technology. Technology is the most boring field for students in sixth grade ( $M = 2.26$ ;  $SD = 0.95$ ) and the least boring for students in ninth grade ( $M = 1.85$ ;  $SD = 0.83$ ). In comparison with other grades, students in the sixth grade perceive technology as a difficult area for which a lot of knowledge and talent is needed.

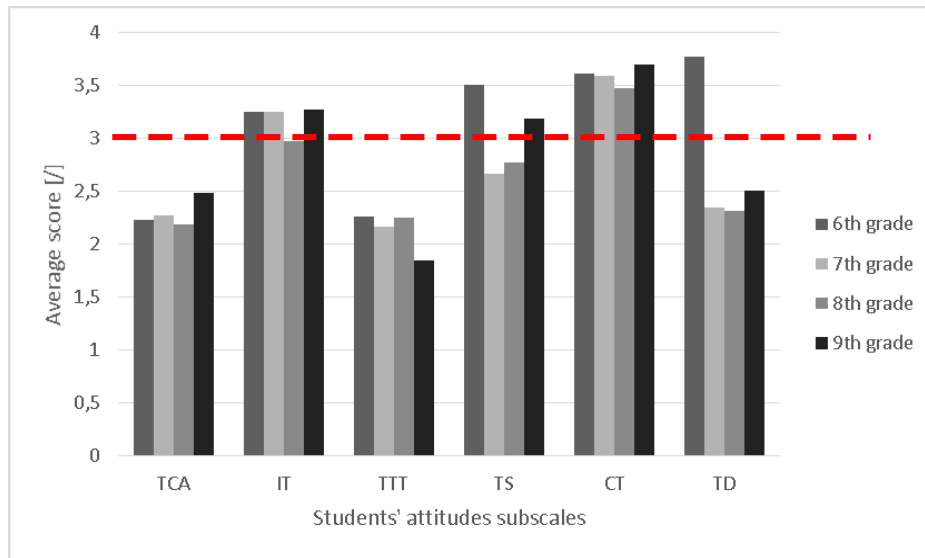


Figure 3: Average score on each subscale on student's attitude to technology with a mid-point 3 ( $n = 415$ ).

### Students' Creative Ability

Considering the assumption of the homogeneity of the variance ( $F = 0.202$ ;  $p = 0.653$ ), the  $t$ -test for independent samples between male and female students showed statistically significant differences in the average scores achieved on the TCT-DP test ( $t = 2.749$ ;  $df = 413$ ;  $p = 0.006$ ). Female students achieved a higher score ( $M = 25.63$ ;  $SD = 9.52$ ) than male students ( $M = 23.05$ ;  $SD = 9.62$ ).

Considering the assumption of the homogeneity of the variance ( $F = 4.046$ ;  $df_1 = 3$ ;  $df_2 = 411$ ;  $p = 0.007$ ), the Brown-Forsythe test showed statistically significant differences between the sixth, seventh, eighth and ninth grades ( $F = 14.192$ ;  $df_1 = 3$ ;  $df_2 = 403$ ;  $p = 0.000$ ). The Games-Howell post-hoc test showed statistically significant differences between the sixth and seventh grades ( $p = 0.002$ ), between the sixth and the eighth grade ( $p = 0.000$ ), and the seventh and ninth grade ( $\alpha = 0.003$ ). There were no statistically significant differences between sixth and ninth grade students ( $p = 1.000$ ). The data show that the highest score was achieved by students in the eighth grade ( $M = 27.635$ ;  $SD = 9.39$ ) and the lowest score was achieved by students in the sixth ( $M = 21.02$ ;  $SD = 8.49$ ) and ninth grades ( $M = 21.00$ ;  $SD = 8.31$ ) (Figure 4). The authors assumed that students' creativity potential increased from grade to grade. The cause of these unexpected results could be attributed to the teaching approaches, which do not contribute to the development of creativity. Furthermore, students are too limited by a teacher or there is no place to express their opinions or to use critical thinking.

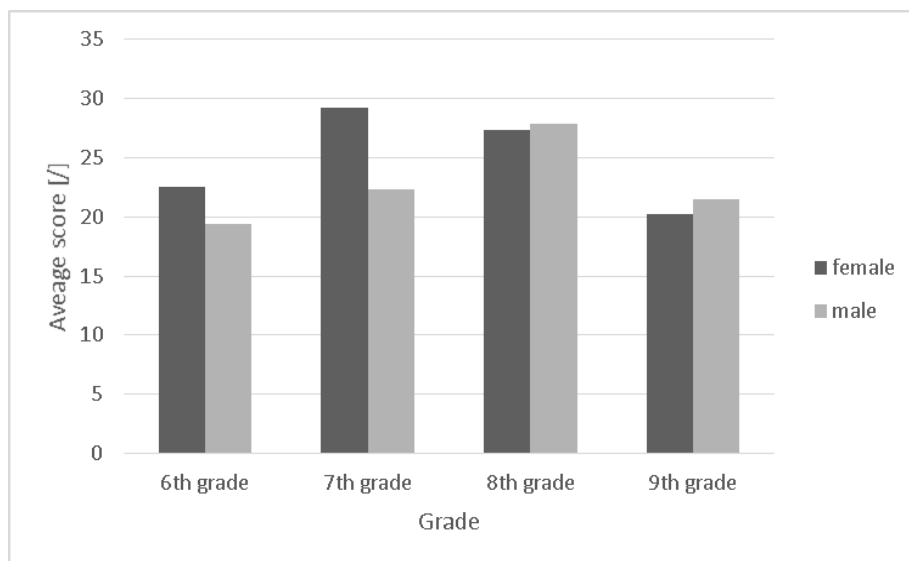


Figure 4: Students' average scores test of TCT-DP.

### Correlations between Students' Attitudes to Design and Technology, and Students' Creative Ability

Correlations between students' attitudes to technology and students' creative ability were verified with multiple regressions. Two categories of students' attitudes to technology predict creativity: TS and CT. Students who are convinced

that technology is only for men ( $\beta = -0.26$ ,  $t = -5.16$ ,  $p = 0.000$ ) achieved a lower score on the TCT-DP creativity test. Students who are aware of the consequences and importance of technology ( $\beta = 0.18$ ,  $t = 3.08$ ,  $p = 0.002$ ) have higher scores on the creativity test, and achieved higher scores.

## DISCUSSION AND CONCLUSIONS

Students scored on average 24.29 points out of 72 on the creativity test. There were statistically significant differences between female and male students. Surprisingly, on average, female students scored higher than male students on the creativity test. There were also statistically significant differences between grades in the study. Students in the eighth grade achieved the highest score on the creativity test. Students in the sixth and ninth grades achieved the lowest scores on the creativity test.

A low level of creativity is probably due to incorrectly chosen strategies and methods in teaching and teacher involvement. The teaching approach is mostly traditional, and the teacher's involvement is too great. Teachers' creativity seems to be an important influencer of the students' creative ability and learning achievements [32]. Creative ability is a crucial factor in students' capacity to solve problems, develop research skills, and to improve their critical thinking and decision making ability [9][13][32].

In the Slovenian school system, creative ability is not encouraged enough; students are limited by textbooks and kits with semi-finished materials. Students do not have opportunities for solving real-world problems. The only opportunity for being creative is when students choose the appearance of their artefact (aesthetic creativity). Students' attitudes to technology present an important area and are strongly connected with students' creative ability. Students' attitudes to technology are estimated as being below the average. The study shows that in general, male students have a positive attitude towards technology, and they are more interested in technology profession than female students. Unfortunately, male students even think that the technology context is suitable only for men and that men are more capable in technical professions than women are.

At school, teachers should make more effort to motivate students. The study revealed some connections between students' attitudes to technology and their creative ability. Students, who think that technology is only for men achieved lower scores on the creativity test. Higher scores were achieved by students who are aware of consequences and the importance of technology. For fostering creativity, the authors suggest the use of methods based on problem solving, to give students the opportunity to participate in class and to collaborate with classmates. Teachers should include interesting content to attract students. For future work, it could be interesting to evaluate creativity from different perspectives and to include personality traits of students and family environment, because the authors' opinion is that these two factors might influence the development of creativity.

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