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Measuring the Influence of Students' Attitudes on the Process of Acquiring Knowledge in Mathematics

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Abstract

In this paper the authors discuss the influence of students' attitudes on the process and results of their studies. The procedure by which a grade for students' attitudes is obtained is very simple, and the results are treated in several ways. A survey has been conducted among the students in elementary school in order to establish their attitude towards Mathematics lessons. By comparing the answers of students to their knowledge, results were obtained indicating that motivation derived from enjoyment in mathematics has a much greater influence than student consciousness about the usefulness of the subject. The reason for this difference lies in the fact that the application of most mathematical areas seems abstract to learners of this age.

Key words: *learning, mathematics education, attitudes towards mathematics*

Introduction

Although the quality of acquired knowledge by some students is in great measure predisposed by their innate abilities, it has been shown that a certain number of students cannot fulfill their potential because of negative motivational beliefs that distract learning (Becker, 2005). Positive examples are also present due to positive motivational beliefs; students have overcome the boundaries of their abilities and achieve better results than expected. The lack of motivation for learning, and its consequences are particularly evident in subjects where students show resistance and a lower rate of interest. The subject where this phenomenon is most visible is Mathematics. Although Mathematics is of great importance for everyday life and has wide application in all jobs, there is great resistance towards this subject by students and by adults as well. One reason for such hostility can usually be heard in statements

as Mathematics is a difficult subject, which is partly true because areas of Mathematics "lean" one on the other, and in order to learn a certain area it is necessary that students know the previous ones, new knowledge builds on what was previously learned. One more reason why Mathematics is not a favorite subject is the lack of interesting content. To most students the great number of formulae, equations and calculations seem uninteresting and dry. And the lack of understanding the reasons behind learning Mathematics is an important factor which has an effect on low motivation of students for Mathematics lessons (Lambić, 2011; Musto, 2008).

Students' attitudes about the subject are very important factors for quality acquisition of knowledge in any field. The attitude towards mathematics is just a positive or negative emotional disposition towards mathematics (Zan & Martino, 2007). Moreover, motivation is considered as key dimension of attitudes (Tapia, 1996). In order to establish a connection between attitude and success of students in mathematics, it is very important to be able to measure attitude, that is, which factors are taken into account. The Fennema-Sherman Mathematics Attitude Scales (1976) was one of the most popular instruments used in research over the last three decades. The Fennema-Sherman Mathematics Attitude Scales consist of a group of nine instruments that measure various factors, including attitudes regarding teachers, parents, etc. However, this instrument is more than 30 years old and is rather time-consuming (108 items, 45 minutes) which can affect the quality of answers received. Subsequent research has questioned the validity, reliability (Suinn & Edwards, 1982), and integrity of its scores (O'Neal, Ernest, McLean, & Templeton, 1988). Melancon, Thompson, and Becnel (1994) isolated eight factors, and they were unable to find a perfect fit with the model proposed by Fennema and Sherman. Mulhern and Rae (1998) identified only six factors, and suggested that the scales may have some limitations. To simplify the instrument for measuring student attitudes, Tapia and Marsh (2004) have developed an instrument with four factors: self-confidence, value, enjoyment and motivation. Self-confidence is found to be positively correlated with achievement, but it may not necessarily imply a cause-and-effect relationship. There is a high probability that a cyclical relationship exists between achievement and self-confidence, where good achievement leads to high self-confidence, which in turn leads to greater achievement (Yee, 2010). That is why the self-confidence factor is omitted from the attitudes that affect student achievement in mathematics, which leaves us with only three factors.

In elementary school "Sonja Marinkovic" in Zrenjanin, a poll was conducted with students in grades 5 to 8 with the aim to discover what attitudes students have towards Mathematics lesson, i.e. whether they consider Mathematics to be interesting and useful. The results obtained were compared with the achievement in Mathematics for each student separately, and the number of answers that showed a positive attitude towards this subject was also compared among groups of students and divided by their achievement in Mathematics. The results are very interesting indicating that the attitude of students towards Mathematics (enjoyment) has a great influence on

the quantity of acquired knowledge (grade). On the other hand, although students showed high level of consciousness about the usefulness (value) of Mathematics in their answers, the poll results show that this projected consciousness has a rather small influence on the quantity of acquired knowledge, which leads to inquire about the reasons why students characterized the matter of Mathematics as useful.

Student attitudes and learning

The innate ability of students for learning does not fully determine the outcome of the educational process but in great measure influences the quality of acquired knowledge and the needed amount of time that students need to invest in order to acquire a certain amount of content. This ability can be observed as a starting position (advantage/disadvantage) of a student in the race for acquiring knowledge. This means that the student can have a great advantage on the basis of his/her predispositions in the learning process, however, other factors such as inner and outer motivation have a great influence on the final aim. This ability (IQ) should not be measured with one number like height and weight but according to the "Theory of Multiple Intelligences" (Gardner, 1983) this ability should be measured depending on the problem we are dealing with. According to Gardner (1983) there are eight types of intelligences, of which for the Mathematics lessons the logical-mathematical intelligence is the most important and assumes the ability of understanding, calculating and thinking in a logical and systematical manner.

Possessing this kind of intelligence gives students a great advantage with respect to acquiring knowledge in the areas of Mathematics, but whether this advantage will be used in right way depends in great measure on motivation. The case of "gifted underachievers" shows that even very intelligent students need positive motivational beliefs towards the subject in order to fulfill their potential. Motivation is all which encourages activity, which directs this activity and determines its intensity and duration. Motivation is important for any other kind of activity in addition to learning. According to the self-determination theory (Deci & Ryan, 1985), motivation can be categorized into three broad categories, namely amotivation, extrinsic motivation and intrinsic motivation. Amotivation occurs when individuals feel that an activity has no value, do not feel competent to complete a task, or do not expect any desirable outcome from the activity (Ryan & Deci, 2000). Extrinsic motivation refers to the desire to engage in an activity which leads to an unrelated outcome (Spaulding, 1992). When students are in question, the extrinsic motivation usually comes from grades and influence of parents (environment). The relationship between extrinsic motivation and achievement in mathematics is weak (Ryan 1982; Yee, 2010). Although extrinsic motivation sometimes has great influence on students' grades, practice has shown that acquired content under such influences is usually of lower quality and of shorter breath. For this reason, this paper will consider only the impact of amotivation and internal motivation, which is defined as the inner desire to accomplish a task,

and pleasure is derived in the process (Berlyne, 1965; Deci, 1975). Inner motivation, when learning is in question, consists of enjoyment and the attitude of student about the subject, on the level of interest and usefulness. Under the influence of inner motivation the quality of acquired knowledge is much greater and it is logical that students memorize the information they consider useful and interesting for a longer period of time.

Vallerand et al. (1992) further categorize intrinsic motivation into motivation to know, to accomplish things, and to experience stimulation. However, motivation defined like this is (completely) overlapped with the attitudes about enjoying the mathematics and its values (Zan & Martino, 2007). Person is motivated to learn information if the information is considered useful or interesting. We accomplish things because we consider it useful or enjoy in it, and we experience stimulation only in activities that we consider interesting and useful. Also the items used for measuring motivation (Tapia & Marsh, 2004) can also be subsumed under the category of enjoyment or value. All of the above reasons are contained in the factors value or enjoyment, so we can say that motivation derives entirely from these two factors. Motivation can be divided into motivation caused by value and motivation caused by enjoyment.

Attitude caused by enjoyment

Adults and especially children are ready to devote much of their time to activities that they enjoy. When it comes to school subjects, enjoyment is largely associated with the attitude of students about how interesting the material is. Students have greater motivation to attend classes and learn the material from the subject they consider interesting.

Therefore: H1. Attitude caused by enjoyment has a positive effect on the process of acquiring knowledge in Mathematics.

Attitude caused by value

The value of mathematics is shown through students' beliefs on the usefulness, relevance and worth of mathematics in their life now and in the future. The potential benefit is a great motivating factor, and the intensity of motivation is directly proportional to the strength of belief on the usefulness of certain activities, and the value of the realized gain.

Therefore: H2. Attitude caused by value has a positive effect on the process of acquiring knowledge in Mathematics.

In addition, a negative attitude towards these factors creates amotivation of students towards mathematics which can result in a negative effect on the process of acquiring knowledge in Mathematics.

Methods

In this study, we used survey method to collect our data. The paper and pencil version was distributed to students through teachers in elementary school "Sonja Marinković" in Zrenjanin (Serbia). A total of 59 surveys were returned and 52 valid surveys were collected. The survey was conducted among students of 5th, 6th, 7th, and 8th grade of elementary school. The questionnaire used in this study had two major sections, one containing questions concerning attitude towards the lessons of Mathematics, whether the matter is interesting and about their attitude towards the usefulness (value) of Mathematics in general and in everyday life. In the other section, students could, voluntarily, write down the grades they have in Mathematics, so the relation between their answers and the level of acquired knowledge set by grades could be established.

The questionnaire was designed in a way that the minimum number of questions covers all significant factors, allowing respondents to complete it with minimal effort. The questionnaire contains four questions (Table 1) divided into two groups. The first and second question measure attitude caused by enjoyment whereas the third and fourth measure attitude caused by the value of mathematics. Apart from these two groups of questions, student responses to all four questions in general will be considered, and will be seen as a general attitude of students toward Mathematics. By comparing the responses of students grouped like this, types of attitudes are sorted by the level of correlation with student knowledge, exposing the amount of influence on the process of learning mathematics.

Students were required to read the statements and to indicate the extent of their agreement on the basis of the options provided on a 5-point Likert scale: totally disagree, disagree, partially agree, agree, and totally agree. Only fully completed surveys (including Mathematics grades from) were taken into consideration.

Results

The data acquired was analyzed in three different ways. Firstly, we observed answers from all of the students in total, in order to obtain data about the general attitude of students towards Mathematics. Secondly, the answers of groups of students divided by success in Mathematics were observed. Finally, the influence of attitudes on acquiring knowledge in Mathematics for each student separately was analyzed.

Table 1. *The attitude of students towards the subject of mathematics*

	I totally disagree	I do not agree	I partially agree	I agree	I totally agree
I consider mathematics interesting	21.15%	3.85%	30.77%	21.15%	23.08%
I like Mathematics as a subject	21.15%	9.63%	26.92%	21.15%	21.15%
I consider Mathematics to be useful	7.69%	9.62%	11.54%	21.15	50%
I do not see the importance of Mathematics for everyday life	30.77%	36.54%	17.31%	7.69%	7.69%

Table 2. *Percentage of positive answers of groups of students divided by success in Mathematics*

Grade in Mathematics	Question 1	Question 2	Question 3	Question 4	Average
Insufficient (Grade 1)	0%	0%	33.33%	0%	8.33%
Sufficient (Grade 2)	11.76%	17.64%	47%	58.82%	33.8%
Good (Grade 3)	40%	26.66%	86.66%	66.67%	55%
Very good (Grade 4)	85.71%	85.71%	71.43%	85.71%	82.14%
Excellent (Grade 5)	90%	100%	100%	90%	95%

In order to establish the influence of attitudes on the knowledge of Mathematics with students more precisely, it is advisable to express the answers of students in the survey with numbers, in other words with grades. Table 3 shows the grades of attitudes that are given for the answers of students on certain questions.

Table 3. Students' attitude grade

For the first, second and third question				
I totally disagree 1	I do not agree 2	I partially agree 3	I agree 4	I totally agree 5
For the fourth question				
I totally disagree 5	I do not agree 4	I partially agree 3	I agree 2	I totally agree 1

From the data received, three grades of attitudes are posed as logical solution for a unique presentation of attitudes of students towards the lessons of Mathematics. If the grades for students' answers on first, second, third and fourth question are presented in order as G_1,G_2,G_3,G_4, then we can define the grades of attitudes in the following manner. The average grade of attitudes A_{av} can be defined as $A_{av}=(G_1+G_2+G_3+G_4)/4$, the grade of attitude derived from students' attitudes towards Mathematics (enjoyment) $A_{en}=(G_1+G_2)/2$ and the grade of students' attitudes derived from consciousness about the usefulness of Mathematics (value) as $A_{us}=(G_3+G_4)/2$. If n students participated in the research and the grade of knowledge of each student is marked with K, then we can calculate the average deviation of each attitude grade from the grade of knowledge in Mathematics with the following formula:

$$O_x=\Sigma_{0\le i\le n}(K_i-A_{x,i})/n \qquad (1)$$

where x can be *av*, *en*, *us*, depending on what kind of attitude grade we want to establish the deviation for. The Pearson product-moment correlation coefficient is used in order to determine the correlation between the knowledge grades with the grade of attitudes.

Discussion

Only 44.23% of students declared that Mathematics is interesting, and 42.3% declared that they like Mathematics as a subject. On the other hand, as many as 71.15% of students declared that mathematics is useful, and 67.31% of them see the importance of Mathematics in everyday life. Data shown in Table 1, presents the general attitude of students towards Mathematics, but much more interesting data were obtained when the percentages of positive answers of the groups of students were divided by success in Mathematics and compared.

Table 2 shows what was expected, i.e. the group of students with better grades in Mathematics has a better attitude towards mathematics. But if we take the average of percentage in positive answers for each of the five groups of students we get very interesting rule. The average of positive answers of groups of students is very close to the percentage of correct answers for grade in Mathematics of the members of the group. This data speaks for the fact that the positive attitude towards the subject in great measure influences the quantity of acquired knowledge.

The percentage of the students from Table 1 who consider Mathematics useful is high, but the question why they think like this remains unanswered as well as whether they truly stand by their claim. By analysis of the grades of attitudes for each student separately and compared with their grades of the knowledge of Mathematics, we come to the conclusion that a much greater influence on the motivation of students comes from their attitude towards enjoyment in subject (answers to first two questions) than student consciousness of the usefulness of Mathematics (answers to 3rd and 4th questions). The produced values of the average deviation of the grade of attitude from the grade of knowledge are following: deviation for average grade of attitudes is O_{av}=0.78, the deviation of students' enjoyment is O_{en}=0.625, whereas the deviation of students' consciousness about the usefulness of Mathematics from the grade of knowledge is the highest and is O_{us}=0.95.

By calculating the Pearson product-moment correlation coefficient we determine correlation for the grade of knowledge with each grade of attitude. The correlation coefficient of grade of knowledge with average grade of attitude is 0.692, with A_{en} it is 0.740 and the correlation coefficient of grade of knowledge with A_{us} is 0.497. This result confirms the hypothesis H1. Students' consciousness about the usefulness of Mathematics has the smallest correlation coefficient with the grade of knowledge and it is less than 0.5 which do not support the hypothesis H2.

This difference in influence should not be that large so the question on the reasons for such high consciousness and usefulness of Mathematics with students

is posed. We come to the conclusion that this consciousness is more a consequence of presuppositions and the influence of the environment (teachers and parents) than their real knowledge. Students say that Mathematics is useful but they are not completely convinced. The reason for this condition lies in the fact that in comparison with IT lessons, the use and application of acquired knowledge from Mathematics are not so visible.

From previously listed reasons, it is completely clear that the attitude of students about the usefulness of Mathematics is not based on real beliefs and as such is not of grater importance on the qualitative process of acquiring knowledge from Mathematics. That is the reason why the grade of attitude A_{en} will be used as the best representative of students' attitudes in further discussions, which is derived from the answers that define students' attitude derived from enjoyment in the subject. The average deviation of this grade of attitude is only O_{en}=0.625, and it has the highest Pearson product-moment correlation coefficient with the grade of acquired knowledge in Mathematics.

Table 4. *Deviation of attitude grade A_{en} from the grade of knowledge*

Deviation	0	0.5	1	1.5	2	2.5
Number of students	42.31%	17.31%	25%	5.77%	7.69%	1.92%

The results from table 4 show that the acquired grade of attitude with as much as 42.31% completely matches the grade of knowledge in mathematics. Only with 15.38% of students the deviation is more than 1, which means that on the basis of the grade of attitude with students, obtained from their attitude towards enjoyment in Mathematics, we can with the probability of around 85% presuppose the grade of their knowledge, with the deviation less than 1. In spite of the small percentage students who have a big difference between the grades of attitude and knowledge, the deviation is average. If we do not take into consideration 5% of students with highest and lowest deviation, then the average deviation is O_{en}=0.565, which is very close to one half. Considering that only integer numbers are used for knowledge grades, and that the difference between final grade and grades' average during the whole year is lower or equal to one half, we come to the conclusion that this deviation is almost equal to deviation allowed in the process of grading.

Conclusion

Mathematics has a wide application in many areas of work and in everyday life. It also significantly influences the development of other scientific areas of study. Besides the obvious importance to mankind, acquiring mathematical knowledge is met by resistance from a significant percentage of students. Therefore, it is very important to determine the causes and the quantity of the influences of negative factors on the process of acquiring knowledge from Mathematics. The research done in this

paper has shown that the attitudes of students have a large influence on the quality of acquired knowledge and that the cases where the grade of attitude caused by enjoyment and the grade of knowledge differ significantly are scarce. The results of the research have shown that the quantity of expressed positive attitude (enjoyment) of students towards Mathematics is almost equal to the quality of acquired knowledge.

The factors that negatively influence the process of acquiring knowledge are negative attitude of students towards lessons of Mathematics, lack of interesting content and lack of concrete examples of application of acquired knowledge. Although there is a belief that mathematical content cannot be presented in an interesting way, by applying multimedia and computers, teachers have much more possibilities to make students interested in their lectures. By developing a greater number of software and games in Mathematics the entertaining component can be drastically increased. Also, the enjoyment of students in mathematics can be increased by creating a positive and fun atmosphere in the classroom, which suits both students and teachers (Chalkiadaki, 2009). Deci (1975) suggests that student's intrinsic motivation can be enhanced by creating opportunities for students to have control over their learning environments and increasing students' perceived competence in completing tasks. Teachers' attitudes towards Mathematics are very important, because their attitude influences the formation of students' attitudes towards the subject (Pavlin-Bernardić et al., 2010). Application of behavioral objective-based (BOBIS) and study question-based (SQBIS) instructional strategies can enable the accomplishmend of a significant positive effect on students' attitudes towards mathematics (Akinsola & Olowojaiye, 2008).

Beside the fact that Mathematics should be interesting, it is very important for students to know that Mathematics is useful. The results of the research show that students think how Mathematics is useful, but their consciousness about usefulness does not reflect their knowledge. This is why it is very important that in addition to thinking it is useful, they should know why it is useful, why it is necessary for them to learn Mathematics and in what way to apply the acquired knowledge. If students would fully understand the reasons for learning some area, their motivation for the lessons would be greater. Need-related experiences have an influence on the emergence and stabilization of interests and interest-related motivational orientations (Krapp, 2005). The application of a great part of Mathematics that is lectured at schools which to most students seems abstract is the reason why searching for a greater number of examples for the application is needed (Lambić, 2011), and also the ways in which this application could be presented. It would be particularly useful if in the education of future teachers of Mathematics special attention was given to this aspect of teaching.

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Mjerenje utjecaja stavova učenika na proces stjecanja matematičkog znanja

Sažetak

U ovom se radu proučava utjecaj stavova učenika na proces i rezultate učenja. Procedura kojom se dobiva ocjena stavova učenika je vrlo jednostavna, a rezultati su tretirani na nekoliko načina. Anketa je provedena među učenicima osnovne škole kako bi se utvrdio njihov stav prema nastavi matematike. Uspoređivanjem odgovora učenika s njihovim znanjem dobiveni su rezultati po kojima motivacija uzrokovana uživanjem u matematici ima mnogo veći utjecaj nego svijest o korisnosti predmeta. Ova razlika postoji zato što primjena matematike djeluje suviše apstraktno učenicima ove dobi.

***Ključne riječi**: učenje, poučavanje matematike, stavovi prema matematici*

Uvod

Iako je sposobnost stjecanja znanja kod nekih učenika u velikoj mjeri predodređena urođenim sposobnostima, utvrđeno je da određeni broj učenika ne može ostvariti svoje pune mogućnosti zbog negativnih motivacijskih uvjerenja koja ih odvraćaju od učenja (Becker, 2005). Postoje i pozitivni primjeri učenika kojima pozitivna motivacijska uvjerenja omogućavaju nadilaženje ograničenja sposobnosti te postizanje rezultata boljih od očekivanih. Pomanjkanje motivacije za učenje, kao i posljedice toga, posebice su vidljivi u predmetima prema kojima učenici pružaju otpor i pokazuju manjak zanimanja. Predmet u kojem je ta pojava najuočljivija je matematika. Iako je matematika od iznimnog značenja u svakodnevnom životu i primjenjiva je u iznimno velikom broju poslova, prema njoj postoj velik otpor koji pokazuju učenici ali i odrasli. Kao razlog tog neprijateljstva najčešće se navodi da je matematika teška, što je jednim dijelom točno zbog toga što se područja matematike „naslanjaju" jedno na drugo te, da bi se napredovalo u određenom području, učenik mora imati solidno znanje iz prethodnih područja, jer je svako novo područje nadogradnja prethodnog. Dodatni razlog zašto matematika nije omiljen predmet leži i u pomanjkanju zanimljivih sadržaja. Većini učenika je velik broj formula, jednadžbi i izračuna suhoparan i nezanimljiv, a nerazumijevanje razloga zbog kojih je matematika važna bitan je čimbenik koji utječe na smanjenu motivaciju učenika za nastavu matematike (Lambić, 2011; Musto, 2008).

Stavovi učenika prema nastavnom predmetu su vrlo bitan čimbenik za kvalitetno usvajanje znanja iz bilo kojeg područja. Stav prema matematici je, jednostavno, pozitivno ili negativno emocionalno raspoloženje (Zan & Martino, 2007). Štoviše, motivacija se smatra ključnom odrednicom stava (Tapia, 1996). Da bismo ustanovili vezu između stava i uspješnosti učenika u matematici, iznimno je bitan način mjerenja stava, tj. koji čimbenici će biti uzeti u obzir. Fennema-Sherman matematička skala stavova (1976) je protekla tri desetljeća bila jedan od najpopularnijih instrumenata korištenih u takvim istraživanjima. Navedenu skalu čini skupina od devet instrumenata kojima se mjere različiti čimbenici uključujući stavove prema učiteljima, roditeljima, itd. Unatoč tome, taj instrument je stariji od trideset godina i zahtijeva dosta vremena za ispunjavanje (108 stavki, 45 minuta), što može utjecati na kakvoću prikupljenih odgovora. Kasnija istraživanja su propitivala vrijednost, pouzdanost (Suinn & Edwards, 1982) i cjelovitost rezultata dobivenih tim testom (O'Neal, Ernest, McLean, & Templeton, 1988). Melancon, Thompson i Becnel (1994) su izdvojili osam čimbenika, ali nisu mogli pronaći model savršeno usklađen s modelom koji su predložili Fenneman i Sherman. Mulhern i Rae (1998) su odredili samo šest čimbenika s opaskom da bi takva skala mogla imati određena ograničenja. Želeći stvoriti jednostavniji instrument za mjerenje učeničkih stavova, Tapia i Marsh (2004) su razvili instrument s četiri čimbenika: samopouzdanje, vrednovanje, uživanje (ugoda) i motivacija. Za samopouzdanje je utvrđeno da pozitivno korelira s postignućem, no ne mora nužno implicirati uzročno-posljedičnu vezu. Visok je stupanj vjerojatnosti da postoji kružna veza između postignuća i samopouzdanja, gdje dobra postignuća vode k visokom samopouzdanju, što pak za posljedicu ima još bolja postignuća (Yee, 2010). Zbog navedenog je čimbenik samopouzdanja izostavljen iz ispitivanja stavova koji utječu na učenička postignuća u matematici, što nas ostavlja samo s tri čimbenika.

Anketu smo proveli u Osnovnoj školi „Sonja Marinković" u Zrenjaninu s učenicima od 5. do 8. razreda s ciljem otkrivanja stavova koje učenici imaju prema nastavi matematike te misle li da je matematika zanimljiva i korisna. Dobiveni rezultati su zatim uspoređeni, za svakog učenika posebno, s uspjehom ostvarenim u matematici. Također je uspoređivan i broj odgovora koji daju pozitivan odnos prema matematici sa skupinama učenika podijeljenima prema njihovom uspjehu iz matematike. Dobiveni rezultati su vrlo zanimljivi i pokazuju da stav učenika prema matematici (uživanje) ima veliki utjecaj na usvojeno znanje (ocjena). S druge strane, iako su učenici u svojim odgovorima pokazali visok stupanj svijesti o korisnosti (vrijednosti) matematike, rezultati ankete pokazuju da ta osviještenost ima relativno malen utjecaj na količinu usvojenog znanja, što nas navodi na propitivanje razloga zbog kojih su učenici matematiku okarakterizirali kao korisnu.

Stavovi učenika i učenje

Učenikov talent za učenje ne određuje u potpunosti rezultate obrazovnog procesa, ali u velikoj mjeri utječe na kakvoću usvojenog znanja kao i na vrijeme koje mora utrošiti da bi usvojio određenu količinu gradiva. Tu sposobnost možemo promatrati kao početnu poziciju (prednost /nedostatak) učenika u utrci usvajanja znanja. To znači da učenik u obrazovnom procesu može ostvariti veliku prednost temeljem svojih predispozicija, no na krajnji rezultat ipak utječu neki drugi čimbenici kao što su vanjska i unutarnja motivacija. Ta sposobnost (IQ) ne bi trebala biti mjerena samo jednim brojem poput visine ili težine, već bi prema knjizi „Teorija višestruke inteligencije" (Gardner, 1983) trebala biti mjerena ovisno o problemu s kojim se bavimo. Prema Gardneru (1983) postoji osam vrsta inteligencije, od kojih je za nastavu matematike najbitnija logičko-matematička inteligencija koja pretpostavlja razvijenu sposobnost razumijevanja, računanja i razmišljanja na logičan i sustavan način.

Posjedovanje takve vrste inteligencije daje učeniku ogromnu prednost tijekom stjecanja matematičkih znanja, no hoće li ta prednost biti iskorištena na pravi način, u velikoj mjeri ovisi o motivaciji. Slučaj darovitih, a neuspješnih učenika nam pokazuje da čak i iznimno inteligentni učenici trebaju pozitivan motivacijski odnos prema nekom nastavnom predmetu da bi u potpunosti ostvarili svoj potencijal. Motivacija je sve što potiče, usmjerava i određuje intenzitet i trajanje neke aktivnosti. Prema teoriji samoodređenja (Deci & Ryan, 1985), motivacija može biti kategorizirana u tri opsežne kategorije – demotivacija, ekstrinzična i intrinzična motivacija. Demotivacija se javlja kad osoba osjeća da neka aktivnost nema vrijednost, ne osjeća se kompetentnom za taj zadatak ili ne očekuje bilo kakav željeni rezultat od te aktivnosti (Ryan & Deci, 2000). Ekstrinzična motivacija se odnosi na želju za uključenjem u aktivnost koja će rezultirati nevezanim ishodom (Spaulding, 1992). Kad su u pitanju učenici, na ekstrinzičnu motivaciju najčešće utječu ocjene i roditelji (okružje). Veza između ekstrinzične motivacije i uspjeha u matematici je slaba (Ryan 1982; Yee, 2010). Iako ekstrinzična motivacija može imati veliki utjecaj na ocjene učenika, u praksi je vidljivo da je kakvoća usvajanja takvog gradiva obično slabija i kratkog daha. Zbog navedenog, u ovom radu su uzeti i obzir jedino utjecaji demotivacije i intrinzične motivacije, koja se definira kao unutarnja želja za ostvarivanjem zadatka i zadovoljstvo koje iz tog procesa proizlazi (Berlyne, 1965; Deci 1975). Intrinzična se motivacija, kad je u pitanju učenje, sastoji od užitka i stava učenika prema predmetu u kojoj mjeri je zanimljiv i koristan. Kakvoća znanja usvojenog pod intrinzičnom motivacijom je obično na višoj razini i logično je da učenici duže pamte informacije koje smatraju korisnima i zanimljivima.

Vallendar et al. (1992) dalje kategorizira intrinzičnu motivaciju u motivaciju znati, postići nešto i iskusiti poticaj. Unatoč tome, tako definirana motivacija je (u potpunosti) zaklonjena stavovima o uživanju u matematici kao i njenim vrijednostima (Zan & Martino, 2007). Osoba je motivirana naučiti neku informaciju ako ju doživljava korisnom ili zanimljivom. Postignuća ostvarujemo jer u tome

uživamo ili doživljavamo korisnim, a poticaj nam daju samo one aktivnosti koje smatramo zanimljivima i korisnima. Isto tako, stavke korištene za mjerenje motivacije (Tapia & Marsh, 2004) mogu se svesti pod kategoriju užitka ili vrijednosti. Sve gore navedeno je sadržano u čimbenicima vrijednosti ili uživanja, stoga možemo reći da motivacija proizlazi u potpunosti iz ta dva čimbenika. Motivaciju možemo podijeliti na motivaciju uzrokovanu vrijednošću nečega i motivaciju uzrokovanu osjećajem ugode.

Stavovi uzrokovani osjećajem ugode

Odrasli, a pogotovo djeca, spremni su posvetiti dosta vremena aktivnostima koje im čine ugodu. Kad se radi o školskim predmetima, ugoda je u najvećoj mjeri određena učeničkim stavom o zanimljivosti sadržaja pojedinog predmeta. Učenici su motiviraniji u pohađanju nastave i učenju sadržaja predmeta koje doživljavaju zanimljivima.

Stoga: H1. Stavovi uzrokovani ugodom imaju pozitivan učinak na proces stjecanja znanja iz matematike.

Stavovi uzrokovani vrijednošću (korisnošću)

Vrijednost matematike predstavlja vjerovanja učenika u korisnost, relevantnost i vrijednost matematike u njihovim životima sada i ubuduće. Potencijalna korist je velik motivirajući čimbenik, a intenzitet motivacije je izravno proporcionalna snazi uvjerenja u korisnost određene aktivnosti te vrijednosti ostvarene koristi.

Stoga H2. Stavovi uzrokovani vrijednošću imaju pozitivan učinak na proces stjecanja znanja iz matematike.

Dodatno, negativni stavovi prema tim čimbenicima demotiviraju učenike prema matematici što može kao posljedicu imati negativan učinak na proces stjecanja znanja iz matematike.

Metode

U istraživanju smo za prikupljanje podataka koristili anketu. U anketi su korišteni samo papir i olovka, a učenicima je podijeljena u suradnji s učiteljima Osnove škole „Sonja Marinković“ iz Zrenjanina (Srbija). Vraćeno je ukupno 59 anketa od kojih 52 važeće. Anketa je provedena među učenicima 5., 6., 7. i 8. razreda osnovne škole. Upitnik korišten u istraživanju sastoji se od dvije cjeline. Prva sadrži pitanja koja se tiču stavova prema nastavi matematike, je li gradivo interesantno i kakav je njihov stav prema korisnosti (vrijednosti) matematike općenito i u svakodnevnom životu. Druga cjelina učenicima pruža mogućnost da (dragovoljno) upišu ocjene koje imaju iz matematike da bi se mogla uspostaviti veza između njihovih odgovora i razine znanja matematike određene ocjenom.

Upitnik je napravljen tako da se s najmanjim brojem pitanja pokriju svi bitni čimbenici, omogućavajući ispitanicima da ga ispune uz minimalan trud. Sadrži

četiri pitanja (Tablica 1) podijeljena u dvije skupine. Prva dva pitanja mjere stavove o ugodi, dok treće i četvrto pitanje mjere stavove o vrijednosti (korisnosti) matematike. Osim navedene dvije skupine pitanja, posebno će se uzimati u obzir je li učenik odgovorio na sva četiri pitanja te će se to promatrati kao opći stav učenika prema predmetu matematika. Uspoređujući odgovore učenika grupiranih na takav način, vrste stavova će se sortirati prema razini korelacije sa znanjem učenika i shodno tome količinom utjecaja na proces učenja matematike.

Od učenika se zahtjeva da pročitaju tvrdnju i na Likertovoj skali od 5 stupnjeva odrede u kojoj mjeri se slažu s navedenim: u potpunosti se ne slažem, ne slažem se, djelomično se slažem, slažem se i u potpunosti se slažem. U obzir su uzeti samo oni upitnici gdje su dani odgovori na sva pitanja (uključujući i ocjene iz matematike).

Rezultati

Prikupljeni podatci su obrađeni na tri načina. Prvo smo promatrali podatke svih učenika, da bismo prikupili podatke o općenitom stavu prema matematici. Drugo, promatrali smo odgovore učenika podijeljene prema uspjehu iz matematike i na kraju utjecaj stavova na usvajanje znanja iz matematike za svakog učenika posebno.

Tablica 1.

Tablica 2.

Kako bismo što preciznije ustanovili utjecaj stavova na znanje matematike, korisno je navesti odgovore učenika brojkama, drugim riječima – ocjenom. U tablici 3 su navedene ocjene stavova prema odgovorima učenika na određeno pitanje.

Tablica 3.

Od prikupljenih podataka tri ocjene stavova se nude kao logično rješenje za jedinstveno predstavljanje stavova učenika prema matematici. Ukoliko ocjene učeničkih stavova na prvo, drugo, treće i četvrto pitanje označimo redom kao G_1,G_2,G_3,G_4, tada možemo odrediti ocjenu stava na sljedeći način. Prosječnu ocjenu učenika određujemo kao $A_{av}=(G_1+G_2+G_3+G_4)/4$, ocjenu stava izvedenu iz stava učenika prema matematici (ugoda) kao $A_{en}=(G_1+G_2)/2$, a ocjenu učeničkog stava izvedenu iz osviještenosti korisnosti matematike (njene vrijednosti) kao $A_{us}=(G_3+G_4)/2$. U slučaju da je u istraživanju sudjelovalo *n* učenika, a da je ocjena znanja svakog učenika označena s „K", mogli bismo izračunati prosječno odstupanje ocjene svakog stava od ocjene znanja iz matematike sljedećom formulom:

$$O_x=\Sigma_{0\le i\le n}(K_i-A_{x,i})/n \qquad (1)$$

gdje „x" može biti „av", „en" ili „us", ovisno o tome za koju vrstu stava želimo ustanoviti odstupanje. Da bismo ustanovili korelaciju između ocjene znanja i ocjene stavova, korišten je Pearsonov produkt-moment koeficijent korelacije.

Rasprava

Samo 44,23% učenika je izjavilo da je matematika zanimljiva, a 42,3% da vole matematiku kao predmet. S druge strane, čak 71,15% učenika je izjavilo da je matematika korisna, a 67,31% uviđa važnost matematike u svakodnevnom životu. Podatci iz tablice 1. daju sliku općeg stava učenika prema matematici, ali još su interesantniji dobiveni podatci kad se usporede skupine učenika podijeljene prema uspjehu iz matematike i postotak pozitivnih odgovora.

Podatci iz tablice 2. očekivano pokazuju da učenici s boljim ocjenama iz matematike imaju i bolji stav prema matematici. No ukoliko uzmemo prosječan postotak pozitivnih odgovora za svaku od pet skupina učenika, uočavamo vrlo interesantno pravilo. Prosjek pozitivnih odgovora skupina učenika je vrlo blizu postotku točnih odgovora članova skupine za ocjenu iz matematike. Ovaj podatak ukazuje na činjenicu da pozitivan stav prema predmetu u velikoj mjeri utječe na količinu usvojenog znanja.

Postotak učenika iz 1. tablice koji matematiku smatraju korisnom je visok, ali ostaje pitanje zašto tako misle i vjeruju li uistinu u tu tvrdnju. Analizirajući ocjene stavova i uspoređujući ih s ocjenama iz matematike, za svakog učenika posebno, dolazimo do zaključka da na motivaciju učenika mnogo veći utjecaj imaju stavovi prema ugodi (prva dva pitanja), nego svijest učenika o korisnosti matematike (treće i četvrto pitanje). Dobivene vrijednosti prosječnog odstupanja ocjene stava od ocjene znanja su sljedeće: odstupanje za prosječnu ocjenu stava je O_{av}=0,78, odstupanje od učeničke ocjene ugode je O_{en}=0,625, dok je odstupanje ocjene osviještenosti o korisnosti matematike i ocjene znanja matematike najveće i iznosi O_{us}=0,95.

Izračunavanjem Pearsonovog produkt-moment koeficijenta korelacije određujemo korelaciju ocjena znanja sa svakom ocjenom stava. Korelacijski koeficijent ocjene znanja s prosječnom ocjenom stava je 0,692, s A_{en} je 0,740, a korelacijski koeficijent ocjene znanja s A_{us} je 0,497. Ovi rezultati potvrđuju H1 hipotezu. Svijest učenika o korisnosti matematike ima najmanji koeficijent korelacije s ocjenom znanja i manji je od 0,5 što ne potvrđuje hipotezu H2.

Razlika u utjecaju ne bi smjela biti toliko velika te se postavlja pitanje zašto su učenici odgovorili na takav način. Zaključujemo da je ta osviještenost više posljedica pretpostavke i utjecaja okružja (učitelji i roditelji), nego njihovog stvarnog znanja matematike. Učenici kažu da je matematika korisna, ali nisu u to baš u potpunosti uvjerena. Razlog tome leži u činjenici da, za razliku od nastave informatike, uporaba i primjena znanja iz matematike nije toliko očita.

Zbog prethodno navedenih razloga očito je da stavovi učenika o korisnosti matematike nisu temeljeni na stvarnim uvjerenjima i stoga nisu od neke važnosti u kvalitetnom procesu stjecanja znanja iz matematike. Iz tog razloga će za daljnju raspravu biti uzete ocjene učeničkih stavova A_{en} koje su izvedene iz odgovora koji određuju stav učenika izveden iz ugode prema predmetu. Prosječno odstupanje te ocjene stava je samo O_{en}=0,625 i ima najviši Pearsonovu produkt-moment korelacijski koeficijent s ocjenom znanja iz matematike.

Tablica 4.

Rezultati iz tablice 4 pokazuju kako se ocjena stava s 42,31% u potpunosti poklapa s ocjenom znanja iz matematike. Samo je s 15,38% učenika odstupanje veće od 1, što znači da na temelju ocjene stava učenika dobivene iz njihovog stava ugode prema matematici, možemo s vjerojatnošću od oko 85% predvidjeti ocjenu njihovog znanja s odstupanjem manjim od 1. Na ukupno odstupanje, unatoč malom postotku, veliki utjecaj imaju učenici kod kojih je razlika ocjena stava i znanja velika. Ukoliko u obzir ne uzmemo 5% učenika s najmanjim i najvećim odstupanjem prosječno odstupanje iznosi O_{en}=0,565, što je blizu jedne polovine. Ako uzmemo u obzir da su za ocjenu znanja uzeti samo cijeli brojevi te da je razlika između konačne ocjene i prosječne ocjene tijekom godine manja ili jednaka jednoj polovini, dolazimo do zaključka da je navedeno odstupanje praktički jednako odstupanju dozvoljenom u procesu ocjenjivanja.

Zaključak

Matematika ima svakodnevno široko područje primjene u različitim poslovima, kao i značajan utjecaj na razvoj drugih znanstvenih područja. Unatoč očite važnosti za ljudsko društvo, stjecanje znanja iz tog područja stvara otpor kod značajnog broja učenika. Stoga je iznimno važno otkriti uzroke i količinu utjecaja negativnih čimbenika na proces stjecanja znanja iz matematike. Naše istraživanje je pokazalo da stavovi učenika u velikoj mjeri utječu na kakvoću stečenog znanja, te da su slučajevi u kojima se stavovi o ugodi i konačna ocjena jako razlikuju, vrlo rijetki. Rezultati su pokazali da je količina pozitivnog stava (ugode) učenika prema matematici gotovo jednaka kakvoći stečenog znanja.

Čimbenici koji negativno utječu na proces stjecanja znanja su negativan stav učenika prema nastavi matematike, pomanjkanje zanimljivog sadržaja te pomanjkanje konkretnih primjera primjene stečenog znanja. Iako postoji vjerovanje da je sadržaj matematike nemoguće prikazati na zanimljiv način, primjenom računala i multimedije, nastavnici imaju daleko veće mogućnosti zainteresirati učenike za svoj predmet. Razvojem većeg broja računalnih programa i igara iz matematike može se značajno povećati zabavna sastavnica tog predmeta. Također se ugoda učenika matematike može povećati stvaranjem pozitivne i vesele atmosfere u učionici, što odgovara i učenicima i nastavnicima (Chalkiadaki, 2009). Deci (1975) predlaže kako je moguće unaprijediti intrinzičnu motivaciju kod učenika omogućavajući im kontrolu okružja poučavanja i povećanu percepciju kompetencija u ostvarivanju zadataka. Stav nastavnika prema matematici je iznimno važan, jer njihov stav utječe na stvaranje stava učenika prema predmetu (Pavlin-Bernardić et al. 2010). Primjenom strategija poučavanja zasnovanih na bihevioralno objektivnom principu (BOBIS) i principu učenja uz pomoć pitanja (SQBIS) može se postići značajan pozitivan učinak na učeničke stavove prema matematici (Akinsola & Olowojaiye, 2008).

Pored činjenice da bi matematika trebala biti zanimljiva, iznimno je važno da učenici spoznaju uporabnu vrijednost matematike. Rezultati pokazuju da učenici misle da je matematika korisna, ali svijest o tome se ne odražava na njihovo znanje matematike. Zbog toga je bitno da učenici, osim što misle da je matematika korisna, saznaju i zašto je korisna, te zbog čega je za njih bitno da nauče matematiku i na koje načine mogu primijeniti stečeno znanje. Kad bi učenici u potpunosti razumjeli važnost nekog područja, njihova motivacija za nastavu bi bila daleko veća. Iskustva proizašla iz potreba utječu na pojavu i stabilizaciju interesa i interesom povezane motivacijske orijentacije (Krapp, 2005). Primjena većine matematike koja se predaje tijekom školovanja, većini učenika je apstraktna i to je razlog zbog kojeg je potrebno pronaći što veći broj primjera praktične primjene stečenog znanja (Lambić, 2011), kao i načina na koje se to može predstaviti učenicima. Bilo bi posebice korisno kad bi se na sve navedeno, tijekom studija, skrenula pozornost budućim nastavnicima matematike.