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CHILDREN WITH REDUCED COGNITIVE EFFICIENCY AND ADDITION OF NATURAL NUMBERS UP TO 20: A CASE STUDY

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Abstract/Izvleček The study deals with teaching and learning the addition of natural numbers up to 20 in the first two years of primary school. The first part presents the theoretical background for addition of natural numbers, the procedural and conceptual approach to addition, and the theory of the additive triad. The causes of the difficulties some children have with the field of the addition of natural numbers are outlined, and the issue of reduced cognitive efficiency is briefly introduced as one of the causes. The second part of the study presents a case study of a girl (7 years old) who experienced difficulty in learning addition. The approaches to and results of remedial tutoring completed by the girl are described. In the discussion, the issue of the addition of natural numbers is incorporated into a broader pedagogical context.

Otroci z zmanjšano kognitivno učinkovitostjo in seštevanje naravnih števil do 20: študija primera

Raziskava obravnava poučevanje in učenje seštevanja naravnih števil do 20 v prvih dveh letih osnovne šole. Prvi del predstavlja teoretska izhodišča za seštevanje naravnih števil, postopkovni in pojmovni pristop k seštevanju ter teorijo seštevalne triade. Očrtani so vzroki težav, ki jih imajo nekateri otroci na področju seštevanja naravnih števil, vprašanje zmanjšane kognitivne učinkovitosti pa je na kratko predstavljeno kot eden od teh vzrokov. Drugi del raziskave predstavlja študija primera deklice (stare 7 let), ki je pri učenju seštevanja imela težave. Opisani so pristopi in rezultati popravnega vodenja deklice. V razpravi je vprašanje seštevanja naravnih števil vključeno v širši pedagoški kontekst.

Keywords:
learning addition, pupils with learning difficulties in mathematics, cognitive efficiency, natural numbers, additive triad, case study

Ključne besede:
učenje seštevanja, učenci z učnimi težavami pri matematiki, kognitivna učinkovitost, naravna števila, seštevalna triada, študija primera

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Introduction

One of the tasks of younger school-age pupils is to master the operations of adding natural numbers. According to the Czech Framework Educational Program for Elementary Education [Rámcový vzdělávací program pro základní vzdělávání] (Research Institute of Education in Prague, 2007) (FEP), the recommended level of achievement in the first period of primary education, is that the pupil perform simple memorized numerical operations with natural numbers, while the minimum recommended level is that the pupil adds and subtracts up to 20 using visual aids. In performing these operations, pupils master various numerical strategies. One possible strategy is to master the basic terms of addition in the field up to 10 and the breakdown of numbers up to 10, which allows them to solve the more demanding subsequent tasks involved in adding up to 20. The range of strategies that pupils may encounter is wide. Not all strategies succeed with certain groups of pupils, and some pupils may have difficulty even acquiring the ability to add up effectively.
This article aims to illustrate by means of a case study the problems pupils can face and how difficult it can be for them to manage the addition of numbers in the field up to 20. This issue lies within the didactics field of mathematics and is discussed in connection with the issue of reduced cognitive effectiveness, based on developmental psychology. The case study aims to accompany the theoretical explanation, i.e., to illustrate the issue with examples. The authors believe that this text (including the case study) could be useful not only for teachers and counsellors in education, but also for tutoring, a developing area of pedagogy. The authors emphasize that professional knowledge of the mathematical-didactic, pedagogical, and psychological fields cannot be underestimated in this area.

Addition of natural numbers: Mathematical background

Addition of natural numbers with a transition – procedure or concept?
Whether dealing theoretically or practically with the issue of teaching the addition of natural numbers in a child's early school years, the first question to answer is whether addition is more of a procedure (i.e., the procedure by which we add through automated terms, etc.) or a concept (i.e., understanding the addition operation, its properties, etc.). It is necessary to consider whether one precedes the other, or both occur simultaneously, whether there can be a procedure without a concept or, conversely, a concept without a procedure.

Jonsson et al. (2014) considers the need for an algorithm; the importance of an algorithm is that it can be determined in advance, and the execution of an algorithm is associated with high reliability and speed. However, the algorithm can be recalled in its original form without any conceptual understanding of it (Jonsson et al., 2014). First, the beginning of the process of addition teaching is described. In mastering the addition procedure, the pupil becomes familiar with and then learns the meaning of the operation through the manipulative activity of grouping elements together and observing what happens when a single group of elements is created out of two groups. Only then does the pupil understand the process and begin to use the symbolic notation with the characters + and =. By working through simple exercises, the pupil learns the basic connections. At this point, addition is a process for the pupil to observe and try to memorize. In the learning phase of the process, it is useful when a pupil forms an opinion, although each operation can be simply learned as a procedure without imagination or creativity. A number can be viewed either as a cardinal number (pupils work with objects and put them together) or as an ordinal number (pupils work with order and can learn it, for example, by stepping on a stepping strip). Then, through certain mechanisms, which we will mention below, the pupil learns the individual procedures needed to handle addition. The procedure is important, but it should not be too mechanical. The idea is to allow the pupil to understand the operation and gradually create the concept of addition. Hejný (2014) introduced the concept of an *additive triad*, which the pupil should aim at during the learning of addition. In the next section this concept is introduced in more detail.

Additive triad – basic concept of arithmetic

According to Hejný (2014), school arithmetic overemphasizes the processes of adding and neglects the development of conceptual approaches. "As a result, the pupil is not able to see the problem as a whole, and his/her solution strategy consists in finding the part of the problem for which he/she has calculative procedures in the memory" (p. 94). To achieve the conceptual perception of arithmetic by pupils in the case of natural number addition, we aim to see the calculation of a + b = c not only as a process but also as a concept, as a trinity (*a, b, c*), which Hejný (2014) calls the *additive triad*. While the procedural aspect of mathematics focuses on the routine manipulation of objects, conceptual knowledge is knowledge-rich in relationships. For example, Hiebert and Lefevre (1986) describe conceptual knowledge as interconnected information rather than isolated information.

Gray and Tall (1994) use the term *procept* to indicate the combination of process and concept and state that the counting *process* is encapsulated in the *concept* of number. There is no doubt that, at the beginning of acquiring addition skills, the pupil goes through a procedural stage in addition. This is a demanding job, where the pupil absorbs important operations and tries to store them in long-term, usable memory so that he/she can solve more demanding tasks with the help of these automated operations. The cognitive and time-consuming nature of this activity seems to have led to the belief that memorization is harmful and counterproductive for pupils. Pupils who needed to count without the help of automated combinations most often counted one by one. This is a lengthy and difficult strategy to transfer to more demanding tasks, such as 23 + 48. Despite a child's ability to absorb new knowledge, making these early combinations is a challenging and long-term activity. One methodology recommends automating all combinations up to ten and then combinations with transitions above ten (e.g., Hruša et al., 1962). Another frequent recommendation is to discuss subtraction almost simultaneously with addition, although many children may have difficulty understanding two operations at the same time. As documented in the literature (Blažková, 2017, pp. 71-73), if the pupil is equipped with automated addition combinations up to 10 and with a transition to 20, it is possible to gradually deviate from the procedure and move towards conceptual understanding of addition. Let us demonstrate the difference between the procedural and conceptual approaches. The instruction for the addition of $7 + 6 = __$ is purely procedural. The pupil need only find the right connection in his/her memory, or in the worst case, can do the calculation one by one. The pupil is in a more difficult situation if the task is presented as $7 + __ = 13$, verbally "seven and how many equals thirteen?" Addition is a simpler operation than subtraction, so if the pupil does not want to convert the task to subtraction, they need to find the combination "7 + 6" in memory. Again, it is possible to calculate one by one.

The task $7 + 6 = 13$ hides four equivalent tasks:

$$7 + 6 = 13$$
$$6 + 7 = 13$$
$$13 - 6 = 7$$
$$13 - 7 = 6$$

Here we are quite close to conceptual understanding and the additive triad $(6, 7, 13)$.

At the same time, if pupils are only at the level of process understanding, and have not mastered this subject conceptually, they see the tasks $6 + 7 = __$, $6 + __ = 13$ a $13 - __ = 6$ as three completely unrelated tasks. The aim is for the pupil to understand that it is the same modified task and therefore to develop a conceptual understanding. Automating combinations can help some pupils gain conceptual understanding. For some pupils, automation never occurs, while conceptual understanding comes almost immediately, as mentioned above. There are also pupils for whom there is neither automation nor conceptual understanding. It is necessary to work individually with each pupil in these groups and understand their particular situation.

Different strategies for mastering addition

There are several approaches for pupils to master the goal of adding natural numbers. We will mention the most common ones here.

1. *Counting one by one*. This is the least cognitively demanding strategy, the results of which are the least useful in other subjects. Two commonly used counting procedures, whether children use their fingers or not, are termed counting-on or counting-all (Fuson, 1982; Groen & Parkman, 1972). The counting-on procedure typically involves stating the larger valued addend and then counting a number of times equal to the value of the smaller addend, such as counting 5, 6, 7, 8 to solve 5 + 3. Counting all involves counting both addends starting from 1. The development of procedural competences is related, in part, to improvements in children's conceptual understanding of counting and is reflected in a gradual shift from frequent use of counting-all to counting-on (Geary & Hoard, 2005).
2. *Memory acquisition of combinations up to 10, then decomposition of numbers*. This is a very cognitively demanding strategy. Its goal is to master all addition combinations up to 10 and all decomposition combinations, which allow the solution of more demanding tasks. Knowledge is formed cumulatively (it piles up on top of each previous item), and it is necessary to work with orders.
3. *Addition according to arithmetic patterns* – Gaidoschik (2015) describes this strategy as "addition without counting". For example, the pupil has to calculate 3 + 4 and remembers the supporting connection of equal sums 3 + 3 = 6. He can, therefore, use this known connection to determine "without counting" that 3 + 4 = 7. In this strategy, pupils use various schemes and formulas that make it easier for them to make calculations.

The method of arithmetic patterns is also used in research by Ellemor-Collins and Wright (2009). Sharma (2015) also states that using *visual clusters* allows some pupils to search for relationships between numbers.

4. *Alternation of previous strategies*. The pupil can alternate these strategies in different ways. Some combinations are automatic; for other combinations, they use a known formula (typically $4 + 9$ calculated as $4 + 10 - 1$), and in situations where it is necessary under stress, they calculate one by one.

For optimal support of the learning process, it is necessary to know which strategy suits which child. Hence it is beneficial to offer a range of strategies for children to learn. However, a problem occurs when strategies are not offered purposefully and systematically. For example, the child may encounter one strategy in mathematics lessons, another strategy in tutoring, another in home preparation with his parents, and an assistant teacher may also come into play. In this case the strategies are mixed, and the child becomes confused.

There are many international research studies concerning the use of these different addition strategies. Some compare the teaching of addition in different countries; for example, Fuson and Kwon (1992) compared teaching in the United States and Korea, to examine why Korean pupils were achieving greater addition skills than American pupils. The authors suggested one explanation might be the Korean way of marking numbers above 10 with the terms "ten one, ten two," etc., which allows pupils to more easily perceive the quantity in each order (Strategy 2). A second reason might be that Korean pupils (but also Chinese, Japanese, and pupils from other Asian countries) learned to add over base 10 employing decomposition, e.g. $8 + 6 = 8 + 2 + 4 = 14$ (read "ten four"). In addition, Korean pupils used their fingers to add numbers with a transition above the base of ten.

Japanese pupils have also shown great success in addition (Murata & Fuson, 2001). One of the strategies that Japanese 1st and 2nd graders use extensively is counting to 5 or decomposing the number 5 (varied Strategy 2). Using this strategy with the example of the $4 + 4$ task, the pupils often proceeded by adding 1 to four and at the same time subtracting one from four, because $4 + 4 = 5 + 3 = 8$. Similar thought processes were involved when solving more demanding tasks, where instead of the number 5, they worked with the number 10. When calculating $7 + 7$, they thought as follows: seven is missing 3 from 10, so they subtract 3 from 7 and add 3 to the second 7, i.e., $7 + 7 = 10 + 4 = 14$ (Murata & Fuson 2001). This strategy is similar to our strategy based on decomposition of the number 10.

For example, one study examined Korean pupils who were taught arithmetic patterns (finger use) and number decomposition in addition teaching and found that these pupils were very successful in addition tasks, as well as using more sophisticated solution strategies, such as memorial addition or use of a known fact (e.g. 6 + 7 = 6 + 6 + 1, where 6 + 6 is a known fact). Japanese pupils also showed high success in counting in the first two years of primary school, and studies report that pupils spend many hours at the beginning of the first grade on decomposition of numbers below 10 and auxiliary calculations based on counting to 5 or 10 or decomposition of 5 and 10.

In the Czech context, Blažková (2017) discusses in detail the strategy where the numerical operation of adding natural numbers is based on manipulation of objects, meaning that we group objects put them together, add them, etc. Previous strategies may be based on this approach when pupils work with objects. Pupils gradually master the memorized combinations of addition in the field up to five, ten, twenty, and one hundred. Blažková (2017) draws attention to the greater complexity of some combinations in the field up to 10, because the $8 + 2$ task is usually easier for a child than the $2 + 8$ task.

At this point, the child should start using addition commutativity for easier memorization. Gaidoschik (2015) maintains that this is one of the principles that should be used in learning "addition without counting." For addition in the field up to twenty, the child must also be able to decompose numbers. For example, 8 + 7 is most often taught as $8 + 7 = 8 + (2 + 5) = (8 + 2) + 5 = 10 + 5 = 15$. The second addend will therefore be decomposed to complete the first addend by 10. Blažková (2017) notes that such decomposition can be challenging for many pupils, so it is replaced with other strategies. E.g., $8 + 7 = (5 + 3) + (5 + 2) = (5 + 5) + (2 + 3) = 10 + 5 = 15$, i.e., both sums are decomposed by the number 5. This procedure involves several steps, as the child compensates for his difficulty in coping with the learning situation by seemingly "complicating" the solution and may take longer to complete the task. Such processes can then be qualified as a consequence of reduced cognitive effectiveness, which is discussed in the following section.

Limited cognitive efficiency and working memory: Psychological background

It is apparent from the previous discussion that the learning of addition (and later subtraction) is not as easy as it may seem at first glance. In addition, the dynamics of the development (maturation) of younger school-age children and possible specific learning difficulties need to be considered. Various external and internal (subjective) factors can cause pupils to fail to learn to count with the transition over ten.

In pedagogical and counselling practice, the term cognitive efficiency is used to refer to the extent and time frame in which the child deals with the concurrence of demands of a learning task (cf. Hoffman, Schraw, McCrudden, 2012), which often has to be achieved in a short timeframe. This leads to the situation where the pupil does not manage to solve the problem or does not solve it in the correct sequence and leads to errors in procedures and results. Hence, cognitive congestion (overload) can occur in pupils, especially in the initial stages of learning. This cognitive congestion in addition learning can be explained by the general theory of *flexible resource allocation* (Kahneman 1973). This theory explains how our attention functions when we process a lot of information in parallel. In principle, a person has only a limited range of cognitive resources that can be used in information processing (cf. Lukesch 2001, pp. 61-64). If the demands of a particular task are high, and especially if some stages are difficult, all available resources are used in the problem solution. If, at the same time, some other aspect of the task requires the use of resources, these will no longer be available. This leads to failure, and in school such a situation manifests itself in "tasks solved only partially". The theory of *flexible resource allocation* has been well developed into a didactic position. In relation to learning, it means (1) developing "selective attention", which is the ability to focus attention on essential aspects of the task and perceive insignificant aspects as marginal, and (2) learning to properly allocate available cognitive resources (implement a "sourcing strategy").

Memory is important in the learning process which is successful when the pupil has mastered certain parts of learning something (e.g., solving mathematical tasks) at the level of routine procedures (i.e., memory). This allows pupils to save their cognitive resources and use them at the more difficult stages. This is often the key to successful problem solving. In short, children need to be helped to manage their cognitive, motivational, emotional, and other resources, especially when they seem to have fewer of these at their disposal.

We use a combination of long-term and short-term memory when adding two numbers, where we activate known combinations in long-term memory (e.g., 3 + 7 = 10), and the short-term memory must maintain all auxiliary calculations. The term working memory is sometimes used for short-term memory to emphasize its role in thinking, rather than its warehouse function (cf. Nolen-Hoeksema et al. 2012). Working memory plays an important role in the thinking involved in solving mathematical problems. Nolen-Hoeksema et al. (2012, p. 332) state: "When one consciously tries to solve a problem, one often uses working memory to store part of the problem. It also uses information retrieved from long-term memory that is somehow related to the problem. To illustrate, imagine that you have to memorize 35 · 8. You need working memory to memorize the entered numbers (35 and 8), the required operation (multiplication), and arithmetic data such as 8 ·5 = 40 and 8 ·3 = 24." It can be seen from this example that, when performing a mathematical operation, the pupil's memory is relatively busy. If the pupil has not sufficiently mastered the basic combinations, the working memory may be overloaded. Another source of difficulty in solving even seemingly trivial tasks is when a child has a reduced working memory capacity. Working memory capacity in general is limited. It has been shown that most people can keep the items 7_2 in memory for a short time (Nolen-Hoeksema et al. 2012). Under certain circumstances, when information is repeated or processed in other forms, information is shifted from short-term to long-term memory. The capacity of long-term memory is considerable, to the extent that some psychologists maintain that it is unlimited, e.g., Nolen-Hoeksema et al. (2012). However, most information is forgotten very quickly. Long-term memorization is supported by repetition, but this can seem boring or overwhelming to pupils. However, memory can be improved by creating real or artificial connections between individual items (Nolen-Hoeksema et al. 2012). For example, Maria Montessori maintained that memorization in mathematics could be supported by using multiple senses i.e., by multisensory learning (Feez 2010). Montessori created didactic material so that the child could work with shape (touch) or colour (sight). The child may have trouble remembering that "$2 + 4 = 6$" and it may be easier to remember that "green plus yellow equals purple". The child uses multiple senses, for example, when working with coloured beads during addition. The child visually perceives the arrangement of the beads (shape scheme), also their colour, and can perceive the amount by touch. Hence *multisensory learning* can be an effective strategy for some children, and it has become one of our important principles in the intervention described below.

Pedagogical consequences: Towards an intervention

Certain conclusions can be drawn from the text presented above for the design of interventions to compensate for these problems. If the goal is to pedagogically support younger school-age pupils (e.g., in the form of tutoring) who have problems with addition and with the transition to numbers over 10, compensatory learning procedures should do the following:

(1) Identify that part of the task where the pupil began to have problems. This can be difficult for teachers in a large group of children, and it requires individual diagnostics. It is necessary to differentiate the tasks according to the difficulty (Hejný 2014) and to monitor the pupil during the solution.
(2) Work with limits to task difficulty. After having identified the pupil's problem, the tasks are chosen to work with what the pupil knows and to target the problem phase.
(3) Provide more clarity and structure when dealing with learning tasks – using various representations and manipulatives to improve understanding of concepts and procedures.
(4) Involve elements of multisensory learning. Using multiple senses can help the pupil overcome difficulties that block memorization and comprehension. If the pupil has the capacity to manage that, it can lead to gradual improvement.

These principles were followed in an intervention with a girl described in the case study below. Because the girl, in the second year of primary school, lacked the basic knowledge and skills for addition, a strategy had to be identified that would lead relatively quickly to the goal. The methodology used was therefore carefully thought out and selected, based on our experience of working with pupils with similar problems.

A Case Study: Research methodology and pedagogical intervention

We – as teacher educators and researchers – are committed to combining two approaches in our work: (a) we develop supportive learning environments and learning tasks, and (b) we do research in this field. One way to document and share these activities within the professional community of teachers is a case study (Janík et al. 2019). *A case study* was chosen here as the research approach, more precisely, a *descriptive and instrumental* case study (cf. Mareš 2015).

In the descriptive function, a case study is used "to describe in detail, a comprehensive phenomenon of real life in the context in which it commonly occurs and takes place" (Mareš 2015, p. 121). In our case, it was a problem of reduced cognitive effectiveness in learning addition in the field up to 20 with a transition over base 10. In the instrumental function, the case study represents a particular case of a general phenomenon to "understand the theoretical questions such as how and why it works in real life" (Mareš 2015, p. 121). In our case, we captured the specific forms of the problem of this pupil's reduced cognitive effectiveness.

The framework of the case study was guided by these questions: (a) What strategies are used by the pupil in solving the tasks before the intervention? (b) Are there changes towards more sophisticated strategies during the intervention? Data for the case study were collected over five months while the pupil was attending the 2nd year of primary school. The data set included interviews with parents and teachers, the pupil's problem-solving tasks captured in workbooks and the pupil's verbal descriptions related to the solution strategies she used. A video of each intervention was recorded, and other contextual information (such as finger use, gestures, facial expressions) was documented. Information for analysis was selected from this extensive data set. In addition to its cognitive aspects, the case study was intended to fulfil a didactic function in that it represents an enrichment of pedagogical practice (cf. Slavík, Stará, Uličná, Najvar, et al. 2017). This should be ensured by capturing "the development of the case in the form of a specific narrative – the story of clinical practice" (*ibid* p. 22). In the next section, we present *the story of clinical practice*, in which we, in the dual role of teachers and researchers, tried to help the child overcome the problems caused by reduced cognitive efficiency in learning addition.

In the case of… Patrika (7 years old) (a pseudonym is used)

Patrika's parents, after a difficult experience with their first daughter in a traditional elementary school, decided to place their second daughter in a recently created alternative (private) school. Teachers here presented themselves as "guides", whose task is not to provide teaching but to help children discover the world. These "guides" were enthusiasts who were experts in various non-pedagogical fields and had a very positive attitude to children, but they were not sufficiently familiar with the didactics of particular school subjects and the cognitive processes of children.

Their lack of pedagogical knowledge and skills meant that they were unable to respond flexibly to their pupil's needs, did not recognize various phenomena appearing in the classroom, refused to reflect on the needs of pupils described in reports from pedagogical-psychological counselling, etc. Problems emerged during the first year of Patrika's education at this school. At first, the parents noticed that Patrika did not make the usual progress in adding up numbers. When they investigated Patrika's workbook, they found no entries. Then they tried to find out how addition was taught at the school. They discovered that pupils stepped on the walking strip but that they did not have to write if they did not want to, and they did not receive any homework.

When it became apparent that Patrika was falling behind, the parents turned to the pedagogical-psychological counselling centre. They learned that, while Patrika showed strong verbal abilities, she also showed reduced effectiveness of cognitive processes (concentration problems, reduced pace, poor performance in working memory) An individual education plan was recommended for Patrika with procedures designed to lead to compensation. When the parents asked the school to come up with an individual plan, they were told that they "did not follow official papers". The parents decided to change schools. They chose a rural school with a "traditional approach" to teaching and learning. However, if Patrika was to succeed, she had to catch up on the missed curriculum. During the summer holidays, the parents and daughter worked together for approximately three hours per day, not only with counting but also writing. Progress was slow, and a lack of working and learning habits created additional issues of concern. Her second-year teacher at the new school made the usual demands of traditional schooling in terms of curriculum. Patrika was not at the same level as the other pupils, and mathematics lessons were especially challenging and worrying. Her most frequent strategy when adding up was counting one-by-one. That strategy failed when she was under time pressure, became tired or lacked concentration, and Patrika guessed the answers.

Analysis of Patrika's difficulties

The lead author of this paper began tutoring Patrika with the aim of creating a better understanding of the concept of a number and fixing in memory the operations needed for addition by visualization and manipulation. As stated above, Patrika was using a one-by-one counting strategy in most cases, and only a few combinations had been memorized (e.g., 3 + 3).

Following the case study framework above, the tutor began by assessing the strategies in use in Patrika's classroom. Addition with the transition was taught with the use of "splits", in which the second addend is decomposed so that the first addend is added to 10. In Figure 1, we can see how demanding this representation may be for some pupils. The pupil has the split from the second addend, the first addend and the first number from the decomposition is on a yellow background – this is to emphasize that these two numbers should have a sum of 10. What was intended to be simple was quite confusing for children like Patrika. In this case, Patrika added up by counting one-by-one and we can see that she made a mistake in all the calculations she worked on herself (in the first three cases she was assisted by the teacher). Some calculations are very striking - for example, in the last case she writes 9 + 9 = 9 + 1 + 1 = 11.

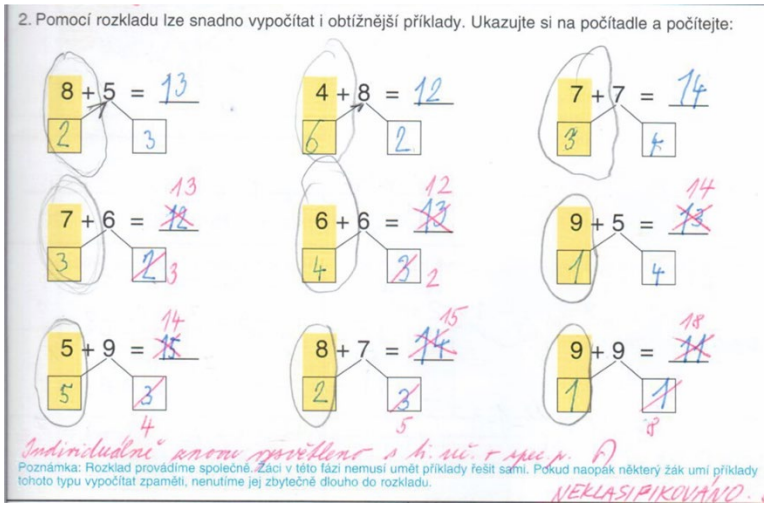


Figure 1: Patrika's difficulties with decomposition of the second addend.

Strategies were alternated in the school's textbook, and we encountered a different representation of the decomposition of the second addend. Figure 2 shows a representation using a rectangle with dots. After ten dots, there is a red line showing the number ten. What would benefit other pupils, was rather harmful to Patrika. She did not know how to follow the scheme and only respected the decomposition strategy if the teacher worked with her. In other cases, she continued to count one-by-one.

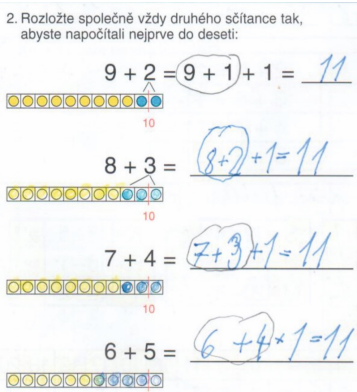


Figure 2: Displaying decomposition of the second addend

For Patrika, the most demanding representation of addition was using a numerical axis, which was incomprehensible to her, and she was unable to follow at all. Figure 3 shows this procedure. The example 4 + 7 is solved by displaying the image of the number 4 and then making 7 arches to the right. However, it is the image of a number on a line that is difficult to understand and imagine for so many pupils.

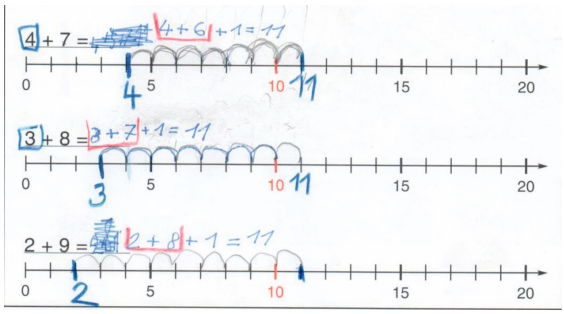
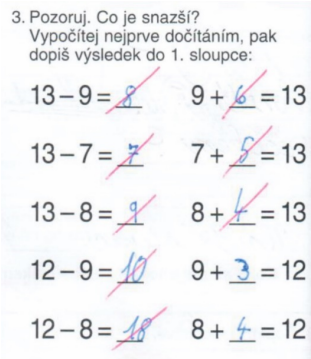


Figure 3: Addition on the numerical axis

At that time, Patrika was also supposed to be dealing with subtraction at school. Since she did not have a clear idea of the addition operations and had no stabilized combinations, subtraction was just another aggravating activity for her. The tasks of adding up to certain numbers and subtracting was generally wrong, as shown in Figure 4, even though she proceeded with the one-by-one counting method. For example, in the case of 13 - 7 = 7 Patrika counted on her fingers one-by-one as follows: 13, 12, 11, 10, 9, 8, 7. This mistake, where the result is higher by one, is frequently made, as pointed out by Blažková (2017).

Interesting but more difficult to explain are the cases 12 - 9 = 10 and 12 - 8 = 18. It can also be noted that on one line, Patrika filled in different numbers, although it is a modification of the same example (e.g. 13 – 9 = 4 and 9 + 4 = 13 on the first line). The intention of the task, to simplify subtraction through adding up, was thus missed.


3. Pozoruj. Co je snazší?
Vypočítej nejprve dočítáním, pak dopiš výsledek do 1. sloupce:

13 – 9 = 8 9 + 6 = 13
13 – 7 = 7 7 + 6 = 13
13 – 8 = 9 8 + 4 = 13
12 – 9 = 10 9 + 3 = 12
12 – 8 = 18 8 + 4 = 12

Figure 4: Patrika's difficulties with addition and subtraction

Based on the analysis, special tutoring for Patrika was developed by the first author of this paper. The four principles listed above were respected.

Tutoring in two stages

This section describes the methodology used in tutoring a seven-year-old girl (Patrika), who had difficulty learning addition and subtraction with transition, probably owing to reduced cognitive efficiency. The main tool used is shown in Fig. 5 and Fig 7. It consists of grids and beads because in our experience the idea of a natural number as a cardinal number is important for a child. The problem, however, is that a number of five or more beads in a pile can only be determined by either arranging them in a written grid with 10 columns and one row or counting them one by one. For this reason, our tool also includes the arrangement into shapes, and the objects have their order (ordinal perception of the number).

Stage 1

The process began with the pupil learning to add natural numbers in the field up to 10. Opinion and manipulation are essential in the activity. During the addition, the two addends are represented by two different colours of beads as in Fig. 5, where the calculation 2 + 5 = 7 is demonstrated. The child puts the beads into the grid one by one and can also perceive the colour and shape scheme – and so has the opportunity to view the process in several ways. The pupil can also write down the results to support the activity.

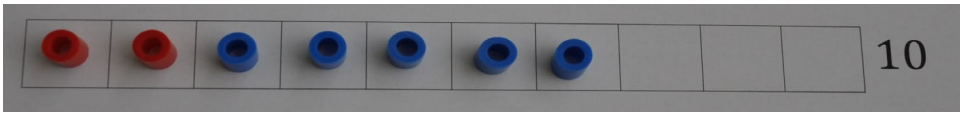


Figure 5: Grid with beeds - using colours when adding up to 10

If the child noted all combinations up to 10, a memory acquisition had occurred. In our experience this activity usually took two weeks. At the same time, the tutor used various strategies to avoid boring the child with endless repetition. For example, colouring books with examples were used (colour corresponds to one result), addition pyramids, oral examination ("two plus five equals"), and later addition ("two plus how much equals seven?"). The speed of the connection is important, but it was necessary to give the pupil as much time as they needed so that they were not stressed. For example, pupils with dyslexia need more time for calculations than pupils without learning difficulties.
Examples of addition pyramids are shown in Fig. 6. On the left is a pyramid with the sum of $2 + 9 = __$, on the right is a pyramid for the addition of $6 + __ = 14$. While for the average child the second option may be only slightly more challenging than the first, mathematically weak children or children with learning disabilities may have great difficulty learning the hidden symbolism.

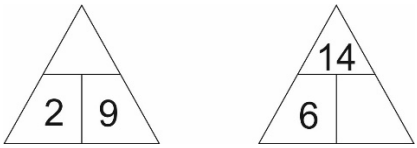


Figure 6: Example of addition pyramids

Decompositions of the number 10 are essential at this stage and thus receive special emphasis. The pupil writes them out separately and learns them by heart. An effective strategy is adding to 10 out loud: the teacher says the number and the pupil says the other number, so the total sum is ten. For example, the teacher says 3, and the pupil answers 7.
Stage 2
The next phase is addition with the transition over the base 10. The acquisition of combinations helps when the pupil uses colour schemes and manipulation. A grid with beads was again used. Tasks were chosen with a result up to 20. Beads of two colours are chosen and placed in a grid. The procedure for calculating $7 + 5 = __$ (Fig. 7) is shown. Seven beads of one colour are placed on the first grid from the left followed by five beads of the other colour. When the top grid of ten is full, the beads are added to the next grid (second ten).

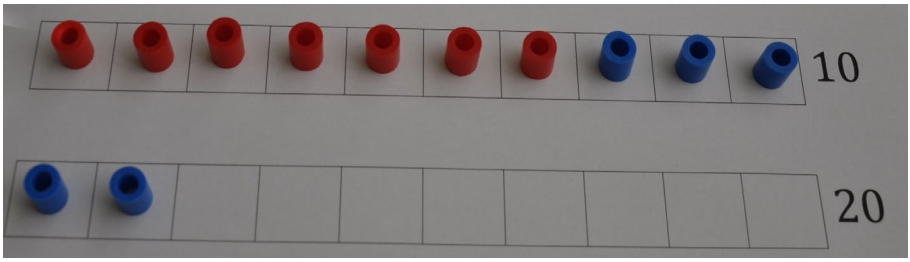


Figure 7: Grid with beeds

What is shown in the grid?

1) Decomposition of the number 10 ($7 + 3 = 10$).
2) Decomposition of the second addend to complete the first to 10 ($5 = 3 + 2$).
3) Overall result ($7 + 5 = 7 + 3 + 2 = 10 + 2 = 12$).

The pupil works not only with numbers but also with colour and patterns. This facilitates the process of memorization and automation. Shape and colour memory are used; therefore, the potential for multisensory learning is implemented. These processes are described in the case study below.

Analysis of Patrika's learning during 2 stages of tutoring

During three weeks of tutoring, plus the regular work of the teacher and assistant teacher at school, efforts by the parents, and Patrika's daily practice, some progress was observed. In some exercises Patrika started to replace the adding up strategy of one-by-one with the decomposition strategies which she had learned through a grid with beads. In some cases, she still counted on her fingers. The error rate fell but did not decrease to zero. While Patrika celebrated her first partial success in the addition of numbers, more and more content was introduced in the school such as subtraction and addition pyramids. These pyramids were problematic for her. For her to successfully solve a pyramid problem, Patrika had to have mastered the whole additive triad, although she was only starting to manage addition. Though the teacher explained the relationships in the pyramid many times, Patrika was overwhelmed with the load of information, as shown in Fig. 8, and in desperate efforts to solve the problems, she invented solutions that she could even justify.

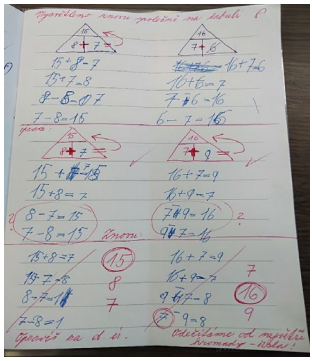


Figure 8: Patrika's problems with addition pyramids

Examine how Patrika considered the pyramid with numbers 15 and 8 (in Fig. 8). She knew that there were three numbers in the pyramid (7, 8, 15) and that she was to find four examples. She could not make other connections, however, because she did not understand the relationship between the numbers. The teacher's effort to

graphically emphasize operations was not effective. Patrika was supposed to come up with four tasks, two for addition and two for subtraction, so she invented them and was not bothered by the fact that her answers did not make sense (she didn't even think about sense at all); for example, 7 – 9 = 16 or 7 – 8 = 16. The girl was exposed to procedurally oriented teaching approaches, and that is probably why she tried to use these procedures in solving other types of tasks. As previously stated, Patrika used different strategies for addition. However, there was no system to their use, and it was not clear what types of examples were associated with which strategies. Patrika was filmed during her tutoring lessons and the transcripts of the lessons demonstrate how Patrika worked. The text features T (tutor) and P (Patrika).

Example 1
T: "Let's try 6 + 8."
P: A few seconds of silence. "Thirteen."
T: "How did you count that, Paty?"
P: "That six plus six is twelve and that six plus eight is thirteen."
T: "Hmm, but eight is two more than six. So, it would be two more than twelve."
P: "Oh, fourteen."

In this recording, we see that Patrika used an automated joint 6 + 6 = 12, called "the lighthouse" by Hejný (2014), and then made the mistake of adding only one unit from six to eight. This error can frequently be seen in children walking on the walking line or playing Ludo. In Ludo, we see a child with the number 5 on the dice connect "one" with the position on which they stand. The child does not count the number of steps (changes), but rather the number of fields, including what should be the "zero" field. Sometimes it was obvious that Patrika had her fingers resting on the table, moving them gently while counting, but imagining them in her mind. She did so because she was not encouraged to use her fingers at school, but needed them as support, so she used them covertly. Keeping the whole process in memory was difficult for her, so she made more mistakes. The tutoring goal was to teach Patrika gradually how to use the decomposition of numbers and adding to dozens. The first strategy she chose was usually one of her older strategies (often finger imagination), which resulted in a poor outcome; then she was asked to use decomposition (see example 2).

Although decomposition was much more certain for her as to the accuracy of the outcome, she still reverted to more deep-rooted strategies (See example 2).

Example 2
T: "7 + 8"
P: A moment of silence, she counts in her mind. "Eighteen."
T: "No. Let's try it by decomposition."
P: "Seven plus eight, I'll add three, and I still have five."
T: "So?"
P: "So fifteen."

To sum up

During the intervention, we documented Patrika's learning achievements, her ability to solve problems etc. Based on routine diagnostics, we observed that by the end she showed fewer errors than at the beginning, as well as errors of a different nature. While at the beginning she guessed more about the results, at the end she was able to use the number decomposition strategy more, although not reliably. Her error rate decreased significantly. While Patrika was dealing with addition over 20, her classmates were subtracting and solving even more demanding pyramids. However, if Patrika was to achieve lasting improvement, it was not possible to speed up the cognitive process. It was clear that Patrika's current skills and the curriculum being taught at school were in conflict. It was recommended that Patrika solve only pyramids with examples of the type 5 + 6 = ____. It was also recommended that Patrika slow down the pace of her learning because she was unable to proceed as quickly as her classmates with the curriculum. Moreover, while her classmates managed to perform addition and subtraction simultaneously, it was important for Patrika that the operations were separated from each other until the operations became more stable. However, it still was not over for her. At school, subtraction, and addition of two-digit numbers had been taught for some time. Understanding the orders in the number was another big challenge for Patrika. While Patrika seemed to have overcome her issues and succeeded in adding up, multiplication was to be taught. The whole process began to repeat; with a new operation, Patrika's addition links were destabilized. She had to face another difficult task.
Patrika was finally successful in understanding the addition operation and stabilizing some combinations during tutoring, which lasted about six weeks.

In answer to the second question of the case study, the intervention had resulted in Patrika developing more sophisticated strategies.

Discussion and conclusions

When a child learns a mathematical operation, they should master both procedural skills and conceptual understanding. In the case study, we looked at a girl who had difficulty with both components. As Hejný (2014) emphasized, children are different; they reach the same goal in different ways and at different speeds. A necessary precondition for such an approach is the need to adapt the process to the individual. If the child is unable to grasp the concept of the additive triad or even unable to handle the necessary procedures as quickly as their peers, it is necessary to proceed to individual education that is tailored to the child. This is difficult if the heterogeneity of pupils in the classroom increases. If the pupil cannot manage addition in the field up to 10 or addition with transition in the field up to 20, this often results in problems that accompany the child throughout their remaining school life, unless the child is able to catch up with the corrective mechanisms. Sharma (2015) states that when children do not automatize facts, they are unable to apply their knowledge to newer situations. To find the answer to a number problem, they digress from the main problem to generate the facts needed for solving problems. Because of the use of inefficient strategies, such as counting, their working memory space is filled in the process of constructing these facts; it is thus not available to pay attention to focus on concepts or relationships etc. (Sharma, 2015). When the methodology was developed for tutoring Patrika, the assumption was made that it was critical to emphasize arithmetic patterns and understand decomposition and addition up to 10, as our experience and some scientific studies suggest. For example, Fuson and Kwon (1992) examined Korean pupils, who were very successful in adding and used fingers for patterns. Similarly, Japanese students were successful in adding and paid close attention to the decomposition of the number 10. In our case study, there was a big shift when the decompositions and patterns were used on Patrika, but apparently the reduced cognitive efficiency resulted in a slower pace of acquisition. Ellemor-Collins and Wright (2009) point out that some children, like Patrika, are unable to quickly and easily add numbers and insist on the least sophisticated strategy of counting one by one. With these children, the authors used the method of creating patterns.

They achieved gradual progress with children, who were able to learn and continue to use some types of patterns. Our intervention with Patrika was also based on the principle of arithmetic patterns. Manipulative colour aids were used to involve multiple senses, thus supporting her memory. Although she quickly forgot new information, she managed to partially stabilize the combinations. Gradually, she also understood the addition operation itself, provided it was not burdened by any other operation (e.g., subtraction). With the implementation of a new operation, the created system always destabilized, and it took some time for the situation to settle again. In many methodologies and teaching systems, the recommendation is to teach subtraction in parallel with addition (e.g., Hruša et al. 1962). As a result of our study with Patrika, we do not recommend this procedure while teaching children with reduced cognitive effectiveness. Although most children can use the relationship between the two operations and learn both things at once, children with reduced cognitive effectiveness find that understanding the operation itself is a problem, learning combinations takes longer, and they are easily forgotten – probably due to cognitive overload, as discussed above. In some approaches, such as Montessori, it is common practice for operations to be implemented separately. After addition is stabilized (automatized) subtraction is introduced (see Feez, 2010).
The case study focused on a girl with reduced cognitive efficiency and her attempts to manage the addition of natural numbers, together with the difficulties that accompanied it. The authors asked two research questions: (a) What were the problem-solving strategies used by the pupil in solving tasks before the intervention? (b) Were there changes in the use of solution strategies towards more sophisticated strategies during the intervention? The answer to the first question is that Patrika initially used a less sophisticated strategy of adding one by one, which failed when Patrika was stressed. As for the second question, during the intervention, an effort was made to accustom Patrika to a more sophisticated strategy, based on decomposition of the number 10. As a result, Patrika learned to use this strategy, but still returned to the more familiar procedure of counting one by one and began to think about decomposition only when she was explicitly asked to do so. However, Patrika's self-confidence and numerical experience did gradually increase, leading to better success in addition. In her early school years, Patrika encountered various difficulties related to the current diversion from the traditional school, in which transmissive teaching and a unified methodology prevailed, which led pupils with the help of drills to a successful goal – automation of addition combinations, although often without the support of conceptual understanding.

From our observations, we draw the following recommendation. When a child has problems with adding numbers, finds it difficult to remember the basic data and does not form correct ideas, it is advisable to prepare a strategy that will be clear, structured and adapted to the child. If he or she uses their fingers, it is advisable not to forbid it. It should be considered that the process will be gradual, and the difficulties will hinder further learning. Therefore, it is important to look for compensations that will help in overcoming the challenge.

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REVIJA ZA ELEMENTARNO IZOBRAŽEVANJE
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ANALOGICAL REASONING IN GEOMETRY PROOFS

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Abstract/Izvleček This study aimed at investigating six high school students' use of analogies while working through geometry proofs in group settings. Along with the analogies used by students and analysis of how they were used, as well as discourse analysis, we investigate students' meta-proof comments to glean some interpretation of students' beliefs about proofs. Overall, this study found that students had different beliefs about the nature and process of proofs and used and understood analogical reasoning in idiosyncratic ways. However, it was also found that students' greater use of analogies did not automatically lead to more success with proofs.

Analogno sklepanje v geometrijskih dokazih
Namen raziskave je bil proučiti uporabo analogije šestih srednješolcev pri razdelavi geometrijskih dokazov v skupinski obliki dela. Poleg analogij, ki so jih uporabljali dijaki, in analize njihove uporabe ter analize diskurza proučujemo komentarje k metadokazom, da bi tako zbrali nekaj interpretacij prepričanj dijakov o dokazih. Če povzamemo, smo s študijo ugotovili, da imajo dijaki različna prepričanja o naravi in procesu dokazovanja ter da so analogno sklepanje uporabljali in razumeli na svojstvene načine. Ugotovili pa smo tudi, da večja uporaba analogij dijakov ne vodi avtomatično v večji uspeh pri dokazih.

Keywords:
Analogical reasoning, cognition, geometry proofs, proving theorems

Ključne besede:
analogno sklepanje, kognicija, geometrijski dokazi, dokazovanje izrekov

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Introduction

While investigating student success in performing proofs in geometry is far from novel, many past studies have investigated whether students are successful rather than how they developed their proofs and which cognitive factors supported or hindered their progress (Bell, 2011; Boesen, Lithner, & Palm, 2010; Lamport, 2012; Magda, 2015; Patkin, 2011; Pfeiffer, 2010; Van Bendegem, 2014; Varghese, 2009). Research has investigated a number of factors associated with student success in performing geometry proofs. Some of these factors are connected with the cognitive style and cognition of the student (Haavold, 2011; Jonsson, Norqvist, Liljekvist, & Lithner, 2014; Park, Moreno, Seufert, & Brunken, 2010; Schwonke, Renkl, Salden, & Aleven, 2011; Tall, 1998, 2008; Varghese, 2009), the algorithmic nature with which they are taught and learn to perform proofs (Bell, 2011; Jonsson et al., 2014; Park et al., 2010; Tall, 1998, 2008; Varghese, 2009), or the common misconceptions students display in the process of completing proofs (e.g., Bell, 2011; Bem, 2011; Frans & Kosolosky, 2014; Grcar, 2013; Hanna & de Villiers, 2008; Lamport, 2012; Patkin, 2011; Pfeiffer, 2010; Stavrou, 2014; Stylianides & Andreas, 2009; Tall, 1998, 2008; Varghese, 2009). Recently, attention has also been paid to the analogical reasoning students employ in performing geometric proofs (Boesen et al., 2010; Lamport, 2012; Magda, 2015). However, few have investigated the meta-proof conversations and attitudes of students involved in performing proofs. What is needed are studies which simultaneously consider the instances and nature of analogies used by students performing geometry proofs and students' attitudes and beliefs regarding proofs. Presently, the interplay of analogies and students' ideas regarding proofs, proof strategies, and student success with proofs has not been firmly established. This study was developed to address some of these concerns. This study seeks to fill gaps in the literature by investigating some of these simultaneous dimensions by examining procedures and order of proof ideas via the lenses of Anderson, Casey, Thompson, Burrage, Pezaris, and Kosslyn (2008), Boesen et al. (2010), Haavold (2011), Lamport (2012), Magda (2015), Patkin (2011), Schwonke et al. (2011) and Tall (2008). We also examine related work on errors, misconceptions, and degree of reliability in mathematical proofs (Bem, 2011; Frans & Kosolosky, 2014; Grcar, 2013; Stavrou, 2014; Van Bendegem, 2014).

Literature Review

Procedures and order of proof ideas

Recent research has investigated how different cognitive styles and cognition match performance on geometry tasks and proving theorems in Euclidean geometry (Haavold, 2011; Stavrou, 2014). While some have addressed it by investigating how proofs can be learned algorithmically, others have focused on creative reasoning (Bell, 2011; Jonsson et al., 2014; Park et al., 2010; Tall, 2008; Varghese, 2009). Some have demonstrated that different cognitive styles influence student techniques and success on proofs in different contexts (Haavold, 2011; Jonsson et al., 2014; Park et al., 2010; Schwonke et al., 2011; Tall, 2008; Varghese, 2009). Although Schwonke et al. (2011) established a relative sense of association between student cognitive styles and proof procedures and strategies, left unresolved was the selection of assessment tasks and the type of reasoning involved in the ordering of proof ideas. Though incompletely established, Boesen et. al (2010) and Pfeiffer (2010) attempted to resolve this by determining the type of reasoning used by mathematics students.

The assumption drawn thus far from Jonsson et al. (2014), Schwonke et al. (2011), and Boesen et al. (2010) is that there is reasonable evidence that the cognitive style employed by students in the context of performing proofs correlates with developing proof competence. What is meant, based on proof ideas and proof competence, is that proofs may have a prescribed order or different directions or multiple solution paths. Proofs may also have definite structures with a specific purpose and end. In addition, some proofs may have paths that are more useful than others and yet formulaic and replicable. As a consequence, it could be conjectured that proof processes are not random but are contextualized natural solution with an existing sequence. Thus, proofs recognize some methodological consistency. On the other hand, proving theorems seeks to emphasize the conversion of verbal problem to pictorial analogies or the reverse. One could also expect to compare pictorial analogy with antagonistic notions, connoting that the picture may be misleading. There are also instances where reasoning becomes subservient to false pictorial analogy.

Magda (2015) advanced this notion by developing a more detailed conceptual understanding of reasoning involved in proving theorems in geometry.

Nevertheless, relatively little has been investigated with respect to reasoning types in the context of proofs (Bem, 2011; Magda, 2015; Patkin, 2011; Schwonke et al., 2011; Tall, 2008; Wiklund-Hörnqvist, Jonsson, & Nyberg, 2014). Instead, the sparse research work examines examples of proofs (Boesen et al., 2010; Frans & Kosolosky, 2014; Lamport, 2012; Stylianides & Andreas, 2009). Nevertheless, it can be argued that procedures employed in proving geometric theorems and the order of ideas provided in a proof may be instrumental in understanding geometric concepts from an analogical perspective.

Numerous authors suggest that students' ability to use analogies and analogical reasoning is valuable, if not necessary, to learning abstract concepts and mathematics new to the student (e.g., Jonsson et al., 2014; Magda, 2015; Patkin, 2011; Stavrou, 2014; Stylianides & Andreas, 2009; Tall, 1998, 2008; Wiklund-Hörnqvist et al., 2014). For instance, while analogies often entail rewriting one mathematical representation (e.g., a verbal statement) into another representation (e.g., a symbolic statement), using analogies differs from performing translations between mathematical representation in that the latter is often prescribed as a task and the former is performed naturally by some students in order to understand, connect, and concretize concepts and solve problems.

In an attempt to investigate how analogical reasoning is applied in geometry, Magda (2015) classified some analogies associated with geometry. First, analogies are recognized as facilitating the comprehension of geometric concepts and the situating of geometric concepts. Magda (2015) defined *analogical reasoning* as thinking that relies upon an analogy, including equivalence, parallelism, similarity, equality, matching, or correspondence. Thus, representational forms of analogical reasoning could be categorized by "…accepted similarities between two systems…" with the view "…to support the conclusion that some further similarity exists" (Magda, 2015, p. 57). Magda (2015) proposes various schemes for solving such analogical reasoning. One such type is shown in Figure 1, which highlights a number of distinct types of analogical reasoning as applied in geometry. The main tenet of Figure 1 suggests that to solve Problem P, one must recognize in it, and distil from it, a problem with more elementary analogues, the Basic Problem (BP), which has in the past been solved. In solving the various steps from 1, 2, …, *n* associated with BP, by using analogy the student can ultimately transform the analogue steps associated with Problem P

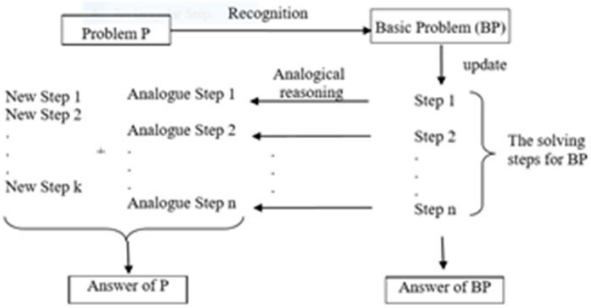


Figure 1. Solving Problem P (Source: Magda, 2015, p. 58)

Second, analogies can build bridges between representations of concepts, theorems, and properties. Verbal representations can be presented with, or through, diagrammatic representations or vice versa. Third, analogies are associated with connecting a particular problem together with the process of solving problems and considering relevant theorems. It is argued that, by observing analogies, it is possible to formulate new mathematical theories. Magda (2015) referred to this form of analogy as a means through which learned/attained concepts, knowledge, and skills are transferred and appropriately used in new states, which may invariably differ from the previous states. Drawing from Magda's (2015) research on types of analogical reasoning, one could deduce that geometry competence can be developed through analogical reasoning. This is attained by considering linkages that exist among concepts, theorems, properties, and similar problems (Anderson et al., 2008; Boesen et al., 2010; Lamport, 2012). Recognizing how to evaluate and synthesize ideas that foster comprehension of analogies existing between various concepts and principles enhances learners' capacity to generalize using analogy. In summary, the procedures for and order of geometric proof are as follows: a well-constructed argument with justifiable reasons contextualized by the problem; certain given information; relevant and auxiliary definitions, theorems, and their properties; and associated statements and reasons. Attention to all of these components, together with available analogies can minimize common errors and misconceptions and increase the degree of reliability of a proof (Grcar, 2013; Stavrou, 2014).

Errors, misconceptions, and degree of reliability in mathematical proofs

Though the relevance, definition, and application of proofs vary from context to context, recent investigation reveals common errors and misconceptions associated with students attempting mathematical proofs (Grcar, 2013; Stavrou, 2014).

Proofs are generally intended to communicate ideas such as "verify, explain, communicate, and systematize statements into deductive systems" (Stavrou, 2014. p. 2). Attempts have been made to understand issues such as "how students learn and solve proofs; teaching techniques of proving; how proofs are validated; how students and teachers perceive proofs; how proofs relate to convincing and refutation; difficulties in the transition of high school to undergraduate mathematics and the extent to which proofs are important in educational settings" (Bell, 2011; Hanna & de Villiers, 2008; Lamport, 2012; Patkin, 2011; Pfeiffer, 2010; Stavrou, 2014, p. 4; Stylianides & Andreas, 2009; Tall, 2008; Varghese, 2009). These issues are closely linked to common errors, misconceptions and to the degree of reliability in mathematical proofs, in that the order is generally associated with techniques, validity, provability, and connectivity with, or transition among, other theorems. Nevertheless, an examination of the types of errors and misconceptions has revealed that there is a tendency to assume a conclusion in order to prove the conclusion of a proof; students use specific examples in proving general statements or abuse and misapply definitions; and in respect to biconditional statements, students often tend to prove only one condition and neglect the other (Stavrou, 2014). Growing bodies of literature regarding the construction of mathematical knowledge suggest rather an ambivalent position. This is because mathematical proofs are epistemically unique and do (not) necessarily correlate with a high level of reliability (Bem, 2011; Frans & Kosolosky, 2014; Grcar, 2013). Since humans are predisposed to errors and subject to various interpretations of theorems, properties and contexts, the opinion on mathematical knowledge and proof is not consistent.

Problem Statement

This study seeks to investigate the instances and nature of analogies used by six students in the context of geometry proofs. Most importantly (and unusual among extant research), we consider the interplay of (a) students' use of analogies and (b) students' ideas regarding proofs, proof strategies, and student success with proofs. Thus, we examine students' order of proof ideas and proving a theorem. In addition (and, again, unusual in the literature), this study recognizes analogies in various forms, such as pictorial (drawn), verbal, relational, physical, gestural, and mental (cognitive, neither physical nor written).

Methodology

Participants and research task

The participants in this study were high school geometry students in North Carolina, U.S. Two distinct groups of students were observed. The group including Student 1 and Student 2 worked through one geometric proof problem and the group including Students 3-6 worked through another geometric proof problem. All six student participants were in the same class, instructed by the same teacher, and had experienced similar learning activities throughout the course. All students were also from the same school system and had all taken the same courses in previous years. The geometric proof problem attempted by each group is identifiable through the transcripts provided below. The geometric proof problems were selected from the geometry curriculum that the students were studying.

Data and analysis

Using a task-based interview design (Goldin, 2000), the two groups of student participants were asked to complete their respective research task. Participants were videotaped as they completed their tasks. Data analysis followed these stages: First, the audio-video recordings were transcribed (Flick, 2009). Second, employing discourse analysis (Wertsch, 1990; Wertsch, Hagstrom & Kikas, 1995), all data (audio-video recordings, participant written work, and transcripts) were reviewed to identify themes (Bogden & Biklen, 2003; Creswell, 2003), and data was sorted into those categories. The researchers particularly sought student understanding of proofs and proof strategies and uses of analogical reasoning while performing geometric proofs. Through the process of check-coding (Miles & Huberman, 1994), researchers' initial coding structures were then compared and contrasted, leading to recognition of similar, different, and missing constructs, and researchers were able to reach consensus (Strauss & Corbin, 1990). The codes developed and employed in this qualitative analysis include those regarding proofs (e.g., students' beliefs regarding proofs, proof strategies, and success with proofs) and analogies (forms, uses, pictorial, relational, verbal, physical, gestural, and mental). In developing this list of observed student analogical techniques we extend and go beyond the majority of the literature regarding student use of analogies. The consensus notes are provided in the transcripts below in order to give the reader more insight into the analysis, coding, and results associated with this study.

Results

Throughout the transcripts provided below, the researchers' consensus notes are included. These notes take two distinct forms. First, in brackets and italics are comments regarding student actions or other aspects to give the reader better understanding of the transcripts. For example: [*Student draws in the segment and marks the perpendicular angle and the segments AD and BD as congruent.*] Second, in braces and italics are observations of *students' beliefs regarding proofs and proof techniques*, and *students' use of analogies* are coded using red and blue fonts. For example: {*Converts verbal problem to a pictorial analogy. An automatic act toward a proof*}. These notes have been retained in the transcripts to assist the reader to see how the researchers interpreted the transcripts and to build reliability and replicability in future similar research. The following discussions begin by initially considering some aspects associated with proofs in respect to the student participants and then considering the domain of analogical reasoning. Thus, we examine students order of proof ideas and proving a theorem via proofs, analogies, connecting proofs with analogies.

It is important to note that the transcripts are replete with errors and misstatements. These have been left intact to more accurately represent the communication of the students. For instance, very often students denoted segments by naming only the endpoints. They would say "*AB*" to mean segment *AB* or $\overline{AB}$. To maintain the simplicity of mathematical reading, when students stated "is congruent to" the notes transcribe "≅". Conjoining these two situations, a student may state that "*AB* is congruent to *BC*" and mean "segment *AB* is congruent to segment *BC*." In other cases, when students name vertices in the wrong order, they are accurately reported and represented in the transcript.

Proofs

The following transcripts are in two parts. The first part comprises a group of two students considering the nature of proof in the context of proving two triangles as congruent. The second transcripts represent a group of four students attempting to prove the isosceles triangle theorem.

On order of proof ideas

S1: I don't know the right order [*of steps for this proof*]. {*Proof has a prescribed order.*}

S2: You can use any order you want that will get you there. {*Numerous directions to proofs.*}

S1: But [*the teacher*] always says that my ideas are out of order. {*Proof has a prescribed order.*}

S2: That can be true. There are some things that can be out of order. {*Proof has structure.*}

S1: Then I can't use ANY order.

S2: Yes and no. You need to keep your goal in mind. {*Proof has a purpose.*}

S1: Prove the last statement in the theorem. {*Proof has a specific end.*}

S2: Right. But you've got to get there. {*Proof has multiple solution paths.*}

S1: That's where I get confused. She says that either I put too much in or I don't put in enough. I wish that she would show us the right way to do it every time. {*Proof is formulaic and to be replicated.*}

S2: It doesn't work that way. You can prove it almost any way you want. {*Proof has multiple solution paths.*} Here's my trick. {*Some solution paths are more useful than others.*} If I need parts or angles to be congruent for the theorem, I know that almost every time I need to show that triangles are congruent. And to show that the triangles are congruent, I need to use either SSS, SAS, ASA, or AAS. {*Analogy made with triangle congruence theorems.*}

S1: I know that those are the ways for the triangles. But I never know which ones to use. {*Proof is formulaic and to be replicated.*}

S2: I use the one that I see based on the information that I know. {*Proof processes are not random; a contextualized natural solution sequence exists.*} If I know that I have two sides congruent, I start looking for either another side for SSS or an angle to get SAS. If I have two angles congruent, I start looking for a side to get either ASA or AAS. If I have an angle and a side congruent, then I will aim for SAS, ASA, or AAS. {*A mental (cognitive, neither physical nor written) analogical connection between geometric elements and theorems.*}

S1: I get that. I really do. But when I get into doing a proof on my own, I get lost. {*Proof has a linear ordering.*}

S2: I think that you forget to prove that the triangles are congruent and look for the information that will do that first. Then you prove that last little piece of the theorem. {*Proofs recognize some methodological consistency. Mental analogical connection of geometric elements with theorems.*}

S1: I can figure out problems, but doing proofs is so tough. For problems, there is usually one way to do it. For proofs, I wish there was only one way. {*Problems are formulaic and mechanical. Proofs should be also.*}
S2: Proofs take a little bit of creativity. {*A subjective component is involved in proofs.*}
S1: I don't want to be creative. I want to get them done the way [the teacher] does. {*Proof is a task to be accomplished, not an experience in which to participate.*}

It is immediately apparent that some students articulated different beliefs regarding the nature of proofs than others. Interestingly, and to be remembered, all student participants were from the same classroom, were taught by the same teacher, and had learning experiences in geometry which were more similar than different. Before considering commonalities and differences between student beliefs, we summarize the beliefs discerned through each student's articulations.

> Student 1: Proofs are formulaic and mechanical, with a prescribed, linear ordering and a specific end.
> Student 2: While there is a subjective component is involved in proofs, allowing for multiple solution paths, some paths are more useful than others. Although variation is possible, a proof has structure and some methodological consistency; proof heuristics are not random and a contextualized natural solution sequence exists.
> Student 3: While there are multiple possible proof heuristics, they are limited in number. Particular facts must be recognized or deduced in order to lead to a direction for a heuristic.
> Student 4: While there may be multiple solutions to a proof, proofs possess a common methodology and some heuristics may be ineffective or advantageous.
> Student 5: Proofs have multiple possible heuristics. Different recognized or deduced information leads to different proof directions.
> Student 6: Different known or deduced facts lead to different proof heuristics, of which there are many.

Common themes emerge from these student perspectives: a proof has structure and some methodological consistency (S2, S4); proofs have multiple solution paths (S2, S4-6), but some paths are better than others (S2, S4); and proof directions are based on recognized or constructed relationships among elements (S2, S3, S5, S6).

Divergent notions from the students' responses include the following: proofs are formulaic and mechanical, with a prescribed, linear ordering (S1), and there are a limited number of possible proof heuristics for a given theorem (S3).

In proving theories in mathematics, mathematicians and geometers have considered the use of various forms of mechanisms, procedures, and ideas regarding the ordering of proofs (Boesen et al., 2010; Gathercole & Pickering, 2000; Haavold, 2011; Magda, 2015; Park, 2010; Stavrou, 2014; Tall, 2008; van den Broek, Takashima, Segers, Fernández, & Verhoeven, 2013; Wiklund-Hörnqvist et al., 2014). The students in this study recognized that there were necessary components to ordering proofs. Most came to understand that the relational information deduced in the problem led to the direction and ordering of the proof. Student 1 believed that this ordering was defined by the teacher and to be replicated. While most students recognized that there should exist proper methodological orderings within proofs, not all were able to discern these.

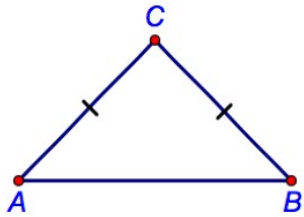
For Students 3-6, the discussion of whether segment *CD* could be an altitude, median, angle bisector, or perpendicular bisector is somewhat revealing. Student 4 created a perpendicular bisector of segment *AB* and assumed that it passed through *C*. He seemed to follow this tack because he did not have a particular direction for the proof. Students who chose the other constructions did so purposely, either because they recognized the direction in which the proof would progress or as an investigatory tool to discern a direction.

Analogies

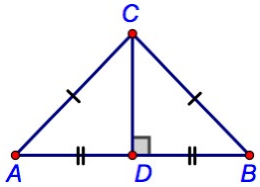
It is apparent through the transcripts that student participants employed analogies in different ways, and often seemed to have different relationships regarding analogies.

On proving a theorem

S3: We're trying to prove that base angles on an isosceles triangle are congruent. So, we can start with this picture. {*Converts verbal problem to a pictorial analogy. An automatic act toward a proof.*}



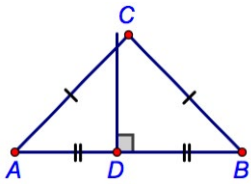
S4: Now we can make the perpendicular bisector. [*Student draws in the segment and marks the perpendicular angle and the segments AD and BD as congruent.*] {*Extends the pictorial analogy. May lack planning regarding the proof.*}



S5: Wait. How do you know that the perpendicular bisector of *AB* goes through *C*? {*Compares pictorial analogy with antagonistic notions, connoting that the picture may be misleading.*}

S4: What do you mean? It's right there. {*Reasoning becomes subservient to false pictorial analogy.*}

S5: We can construct a perpendicular bisector, but it might not go through *C*. Like this. {*Employs a pictorial analogy counterexample.*}



S4: But for that to happen, *D* is not at the midpoint. {*Constructs analogy between the picture and known geometric ideas.*}

S6: How do you know? It's marked as it is. {*Didactically challenges others to reconsider pictorial analogies.*}

S5: Yours could be really close to going through *C*, but not exactly. {*Introduces analogy regarding proximity.*}

S4: But we always use perpendicular bisectors. {*Returns to a previous analogical idea. Believes proofs possess a common methodology.*}

S5: From the midpoint on the line, not to a point off the line. {*Introduces a mental analogy of a line and point.*}

S4: I don't get it. {*Does not connect with previous student's analogy.*}

S3: Ok. [*Using hands and gesturing from down to up.* {*Introduces a gestural analogy.*}] We can't raise a perpendicular bisector from *AB* through *C*. But can we drop a perpendicular bisector from *C* to *AB*? {*Returns to a mental analogy regarding a point and a line.*}

S4: Isn't that the same thing? {*Mental analogy from S3 is ineffective.*}

S6: [*Pointing at the diagram.*] You can drop a perpendicular to *AB*, but you don't know that it will hit at a midpoint… {*Returns to a previous pictorial analogy. Refining possible proof heuristics.*}

S5: Or you can drop a median from *C*, but then you won't know if it is perpendicular. {*Providing additional proof heuristics.*}

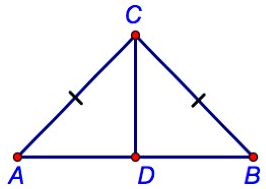
S4. What if *AB* is above *C*? {*Introduces a mental analogy.*}

S5: What do you mean?

S4: If *AB* is above *C*, then we drop the line from *AB* to *C*. {*Employs the mental analogy.*}

S6: No. 'Drop' and 'raise' don't really mean going down or going up. It means going from and going to. So, the first thing is where we start and the second thing is where we end. {*Employs and extends a verbal analogy.*}

S3: [*Dismissing the previous discussion of raising and dropping as inconsequential.*] But we still need the line, like this. But what is it? {*Develops a new pictorial analogy. Recognizes that the segment is a component of the proof.*}



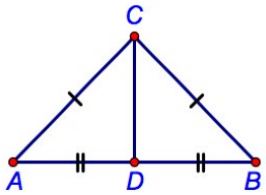
S5: I think it can be a couple of the things already said. It can be a perpendicular from *C*, or a median from *C*. {*Proofs have more than one possible heuristic.*}

S4: Is one better than the other? {*Some possible proof heuristics may be more advantageous.*}

S6: I like the median. It gets me to the easiest proof. Because we need to prove the base angles [*∠CAB and ∠CBA*] congruent, we need to first make the triangles congruent. The median gets me to SSS. {*Introduces analogy of triangle congruence. Recognizes the value of the median toward triangle congruence and the necessity of the latter in respect to this proof.*}

S3: What do you mean?

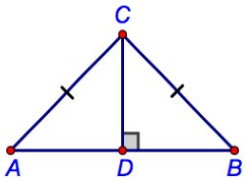
S6: [*Pointing to and editing the previous picture.*] Look. With the median from *C*, *AD* is congruent to *BD*. And I already had AC is congruent with *BC*. Now, *CD* is congruent to itself. {*Enhancing pictorial analogy. Developing and verifying a proof heuristic.*}



S4: That's great. Because the triangles are congruent, then CPCTC [*congruent parts of congruent triangles are congruent*] and $\angle CAB \cong \angle CBA$. We have a proof.

S3: [*Speaking to S6*] But you said that we can use other lines. Can we do the perpendicular from *C* to *AB*? {*Considers a mental analogy. Considers another proof heuristic.*}

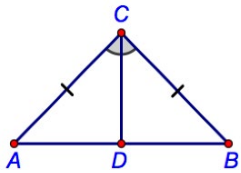
S5: I think so. Let's see. [*Draws the accompanying picture.*] That gives us $\angle ADC \cong \angle BDC$, $AC \cong BC$, and $CD \cong CD$. That gives us SSA. Oh oh. That's ASS, which is not one of our choices. {*Constructs pictorial analogy and makes analogy with known theorems. Recognizes a false proof heuristic.*}



S4: So, we can't use the perpendicular from *C*. {*Recognizes that some proof heuristics are ineffective.*}

S3: I guess that's it. {*Assumes that all potential proof heuristics have been considered.*}

S6: What about an angle bisector at *C*? {*Introduces a mental analogy. Investigates another proof heuristic.*}



S3: Let's try. [*Draws the accompanying figure.*] That gives us… Hey, we have SAS. {*Employs pictorial analogy and connects with analogy using an additional triangle congruence theorem. Investigates and uses another proof heuristic.*}

S4: Hey. Too fast. How do you know that the angle bisector goes through *D*. {*Finds S3's analogy too quickly developed and used.*}

S5: No, it is not that the angle bisector goes through some point *D* already there. The angle bisector goes through *AB*. We make that point *D*, no matter where it is. So, the angle bisector goes through *AB* and that point is *D*. {*Employs verbal analogy.*}

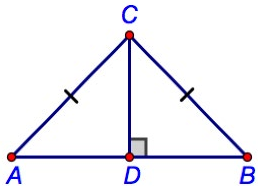
S3: We have $AC \cong BC$, $\angle ACD \cong \angle BCD$, and $CD \cong CD$. {*Employs analogies regarding congruence. Considers the components of congruence in respect to the proof.*}

S4: Cool. {*Accepts analogies from others. Recognizes completion of the proof.*}

S5: Now I think that those are all the options: a median and an angle bisector. {*Verification of multiple proof heuristics.*}

S6: And which one we picked led us to another choice of SSS or SAS. {*Different proof heuristics lead to different results.*}

S3: We couldn't do ASA or AAS. But can we look at the perpendicular again? [*Constructs the accompanying figure.*] We have $AC \cong BC$, $\angle ADC \cong \angle BDC$, $\angle ACD \cong \angle BCD$, and $CD \cong CD$. That seems like a lot of stuff. {*Constructs pictorial analogy using another construction analogy. Considers congruences and how these lead to a possible proof heuristic.*}



S5: How do you know that $\angle ACD \cong \angle BCD$? {*Reconsiders pictorial analogy through congruence. Questions how this construct will lead to a proof.*}

S2: Doesn't it? {*Angle congruence analogy may supersede reasoning.*}

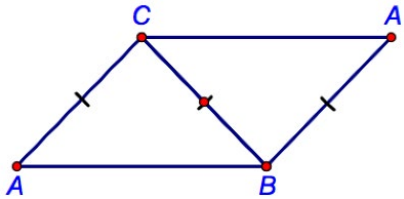
S5: We know it does, but not yet. After we get congruent triangles, then we can CPCTC it. {*Recognizes direction in the proof.*}

S3: Ok. We don't have $\angle ACD \cong \angle BCD$. But we still have $\angle ADC \cong \angle BDC$, $AC \cong BC$, and $CD \cong CD$. That seems like an awful lot to not be able to do anything with. {*Considers necessary information for a proof.*}

S5: Let's work through the list again. For SSS, we would need $AD \cong BD$. We don't have that. For SAS, we would again need $AD \cong BD$. For ASA, we would need $\angle ACD \cong \angle BCD$; but we don't have that either. For AAS, we would again need $\angle ACD \cong \angle BCD$. Those are all of our options and none of them work. {*Makes analogies across required element congruences and triangle congruence theorems. Recognizes information regarding elements leads to different proof directions.*}

S3: So, we got all the proofs. {*Believes that proof directions are limited.*}

S6: All the proofs using that kind of a segment. We could rotate the triangle on one side, get a parallelogram, and then use alternate interior angles. But that would be a lot harder. {*Introduces a new analogy involving a parallelogram. Considers new proof heuristic.*}



Before considering commonalities and differences among student beliefs in the next section, we summarize each student's use and beliefs regarding analogies.

Student 1: Made no discernible use of, nor comment about, analogies.

Student 2: Made analogies with known theorems and employed a mental (cognitive, neither physical nor written) analogical connection between geometric elements and theorems. He encountered an angle congruence analogy that seemingly took pre-eminence and may have hindered further reasoning.

Student 3: Considers a mental (cognitive, neither physical nor written) analogy forwarded by another. He constructs pictorial analogy using construction analogies and employs analogies regarding congruence. He introduces a gestural analogy and uses a mental analogy regarding a point and a line.

Student 4: Accepts analogies from others, but does not always understand them. He constructs and extends analogies between a picture and known geometric ideas and employs mental (cognitive, neither physical nor written) analogies of his own making and from others. His reasoning becomes subservient to false pictorial analogy and he returns to a previous analogical idea.

Student 5: Compares a pictorial analogy with antagonistic notions, connoting that the picture may be misleading. He constructs pictorial analogy, makes an analogy with known theorems, and employs a pictorial analogy as a counterexample. He employs a verbal analogy, introduces a mental (cognitive, neither physical nor written) analogy of a line and point, and introduces an analogy regarding proximity. He makes analogies across required element congruences and triangle congruence theorems and reconsiders a pictorial analogy through congruence.

Student 6: Didactically challenges others to reconsider pictorial analogies. He employs and extends a verbal analogy, enhances a pictorial analogy, and introduces a mental (cognitive, neither physical nor written) analogy. He introduces a new analogy involving a parallelogram and an analogy of triangle congruence.

Discussion

Geometry problem solving has often been characterized by illustration of diagrams as a central heuristic (Bell, 2011; Hanna & de Villiers, 2008; Lamport, 2012; Lin & Lin, 2011; Patkin, 2011; Pfeiffer, 2010; Stavrou, 2014; Stylianides & Andreas, 2009; Tall, 2008; Varghese, 2009). The argument is that most diagrams provide images that are sufficiently obtainable and visualized for problem solving. However, in the context of geometry, it is readily noticed that the student participants in this study employed analogies in numerous ways: making analogies with known theorems; employing mental (cognitive, neither physical nor written) analogies; constructing pictorial analogies; employing analogies regarding geometric relationships; using gestural analogies; comparing pictorial analogies with antagonistic notions; and employing verbal analogies; using an analogy regarding proximity. These varied uses of analogy are consistent with Magda (2015), who recognizes the use of analogies as a creative act. Notably, analogies seem rarely singular; rather, they seem to be interconnected and multimodal.

Analogies are used both as a tool toward geometric proof and as a mechanism of communication. The transcripts demonstrate that a number of these students employed analogies to personally interpret and solve the respective problems. However, in the natural flow of conversation, students also used analogies to communicate their ideas to others. The student transcripts seem to reveal that, while some analogies effectively communicate ideas to others, occasionally this communication is ineffective, since the listener does not seem to grasp the analogy (e.g., Student 4). This may imply that analogies are more idiosyncratic – both in the presenting and in the receiving of such – than previously noted.

While analogies are employed to solve geometric problems and complete proofs, they may also have inhibiting characteristics. For instance, Student 4 seemed to become stymied by some analogies. First, he becomes unable to consider that his analogy could be incorrect and then balks because Student 3's analogy is too quickly constructed and employed without Student 4 fully digesting it. Second, his reasoning seems to become subservient to even his own analogy; once he draws an analogical diagram, he cannot see beyond the fact that it may be incorrect.

Connecting proofs with analogies

While students' use of analogies – particularly diagrammatic analogies – may be helpful in constructing geometric proofs (Bell, 2011; Hanna & de Villiers, 2008; Lamport, 2012; Lin & Lin, 2011; Patkin, 2011; Pfeiffer, 2010; Stavrou, 2014; Stylianides & Andreas, 2009; Tall, 2008; Varghese, 2009), their use seems far from guaranteeing the successful completion of proofs. Indeed, some analogies seem to have the occasional effect of impeding some students and hindering them from progressing beyond the analogy (e.g., Students 2 and 4); some students hear analogies posed by others but do not necessarily grasp them (e.g., Student 4); and some analogies may be misleading (e.g., Students 5 and 6). The fact that analogies may not necessarily lead to success in geometric proofs may be for a number of interconnected ideas: First, since the use of analogies is idiosyncratic, no particular analogy seems to be a panacea for any situation. Second, not all analogies are understood in the same way among individual students. Third, not all analogies effectively communicate ideas. Fourth, in fluid conversation, analogies seem to be posed, used or discarded, and extended or replaced with amazing quickness, with little time for the interlocutors to adequately digest each subsequent analogy. Thus, it is difficult to ascertain the full effect of any analogy.

There is much agreement in the literature that that most mechanisms used in proofs rest on the following: (1) visual (enactive) proof of geometric statements; (2) graphic proof of numeric and algebraic statements; (3) proof in arithmetic by specific and generic calculation; and (4) algebraic proof by algebraic manipulation (Tall, 1998). Some have argued that geometric proofs are often reduced to using generalized arithmetic or algebra to justify conjectures (Bell, 2011; Jonsson et al., 2014; Park et al., 2010; Tall, 1998; Varghese, 2009). In the act of performing proofs, Magda (2015) has also proposed the use of algorithmic and creative reasoning. Summarily, analogical reasoning in proving theorems in geometry incorporates the list provided by Tall (1998, along with algorithmic and creative reasoning as commonly typified (see Fig 2) by visuals, numeric and algebraic symbolism, specific and generic concepts and theorems, as well as algebraic manipulations.

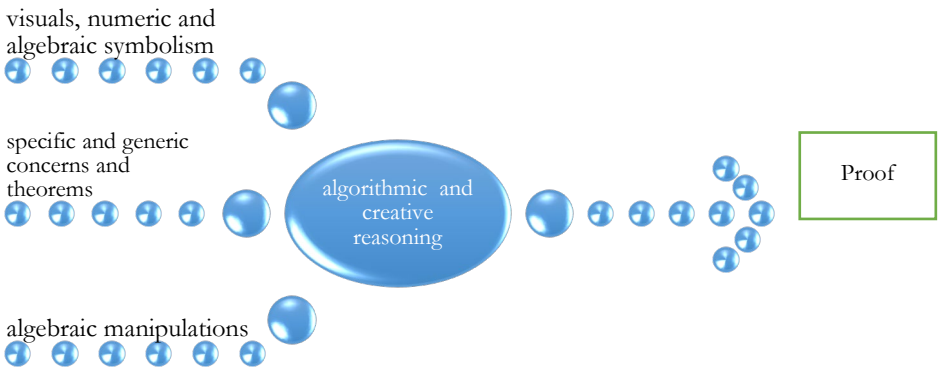


Figure 2. Analogical reasoning in proving theorems

Implications

While this study may have yielded valuable findings, the implications may be of even greater value. Some of these implications are discussed below. The use of analogies has value in the completion of geometric proofs. Therefore, it may seem reasonable that educators should seek opportunities to teach students how to use analogies. However, teaching students to employ analogies may be very complex, particularly when analogies can be recognized to take a myriad of verbal, pictorial, theoretical, mental (cognitive, neither physical nor written), or even gestural forms, and each person finds some forms and uses to be more personally useful and comprehensible than others. It may not be feasible to teach students such a great variety of analogical types, particularly when some types would not be found meaningful or valuable to individual students. As previously discussed, the use of analogies seems to be idiosyncratic to the student. This again would make the teaching of analogies equally idiosyncratic and possibly quite difficult in the classroom. The nature and natural uses of analogies seems to further imply that instruction regarding such would be problematic. The nature and use of analogies seem to be constructed upon one another, be logically nonlinear, and not be equally understood among students. Unfortunately, these implications bode poorly for teaching students about, and regarding the application of, analogies. It may be that the use of analogies is too idiosyncratic to be useful fodder in the classroom. Even if students could be taught to more freely employ analogical reasoning, there is no current understanding that this reasoning will be employed effectively by each student.

Concluding Remarks

In short, this study reveals how very far we need to go to gain a more comprehensible and useable understanding of students' use of analogies, particularly in the context of proofs, before we can make more definitive claims regarding how to increase their use of analogical reasoning. However, we hope that we have cleared a path for others to continue this avenue of research.

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Occupational and Educational Expectations of Rural youth in Croatia

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Abstract/Izvleček The present study is as an attempt to understand how socio-demographic characteristics (i.e., gender, family socioeconomic status) and school level supports (i.e., school climate, professional guidance at school) influence occupational and educational expectations among rural youth (i.e., aspirations for a meaningful career, future family values, and future employment goals). The findings showed a relationship among the demographic characteristics, school level supports, career aspirations and future family and employment expectations of rural youth. The results of regression analysis indicate that school climate does influence aspirations towards a meaningful career, future family orientation and future employment goals. In addition, aspirations towards a meaningful career are also influenced by gender and professional guidance at school.

Profesionalna in izobraževalna pričakovanja podeželske mladine na Hrvaškem Predstavljena študija je poskus razumevanja, kako socialno-demografske značilnosti (tj. spol, družinski socialno-ekonomski status) in šolska raven (t.i. šolska klima, poklicno usmerjanje v šoli) vplivajo na poklicna in izobrazbena pričakovanja podeželske mladine (t.i. težnje po smiselni karieri, prihodnjih družinskih vrednotah ter prihodnjih zaposlitvenih ciljih). Ugotovitve so pokazale, da obstaja povezava med demografskimi značilnostmi, podporo šole, poklicnimi usmeritvami in bodočimi pričakovanji družine ter možnostmi zaposlitve podeželske mladine. Rezultati regresijske analize kažejo, da šolsko ozračje vpliva na težnje po smiselni karieri, bodoči družinski naravnanosti in prihodnji zaposlitveni usmerjenosti. Ob tem na nagnjenje k smiselni karieri vplivata tako spol kot strokovno usmerjanje v šoli.

Keywords:
educational expectations, family values, professional expectations, rural youth, school climate

Ključne besede:
izobraževalna pričakovanja, družinske vrednote, poklicna pričakovanja, podeželska mladina, šolsko ozračje

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Introduction

Educational policy impacts schooling opportunities in rural communities, and it is important to recognize the strong connections and commitments many rural young people have toward their community (Schafft, 2016). In Croatia, education and educational attainment are highly valued in society. As a European Union (EU) member, Croatia is known for emphasizing the importance of education, with an emphasis on making sure children graduate from high school. According to the latest statistical data, Croatia has the lowest high school dropout rate in the EU, with only 3.3% of students leaving school early (European Commission, 2020). Research suggests that academic achievement is associated with a student's socioeconomic status (SES) (Berliner, 2006; Ruiz, McMahon & Jason, 2018) and that there is a link between educational attainment and health status (Cutler & Lleras-Muney, 2011). Within the Croatian context, inclusive measures directed towards children from disadvantaged groups are implemented at a very early age (Macura Milovanovic et al., 2014). Moreover, teacher education programs in Croatia emphasize the development of more inclusive schools to ensure that every child has the opportunity to reach his/her fullest potential (Batarelo Kokić, Kurz, & Novosel, 2016).

However, resources are not always equally distributed across rural and urban schools. The lack of resources in rural areas can result in a decrease in occupational and educational opportunities (Byun, Meece, Irvin, & Hutchins, 2012). The present study was conducted as part of a larger study on the youth aspirations and demographic changes in rural Croatia, in an attempt to understand how demographic characteristics (i.e. gender, family SES) and school level supports (i.e. school climate, professional guidance at school) influence the occupational and educational expectations of rural youth (i.e. aspirations for a meaningful career, future family values, future employment goals)*(The presented results are part of the project "Youth Aspirations, Identity, and Demographic Change in Rural Croatia: Implications for Education and Rural and Regional Development" (2017-2018). We thank Pennsylvania State University and the University of Split for funding this research project.)* The primary objective of this research is to investigate the relationship between demographic characteristics, school level supports, and the occupational and educational expectations of rural youth. With this research agenda in mind, we explored the following research questions:

(1) What are the levels of perceived attitudes towards the school climate, school professional guidance, aspirations for a meaningful career and future perspectives among rural youth? (2) Is there a relationship between demographic characteristics, school level supports and occupational and educational expectations among rural youth? (3) What is the direction of the association between demographic characteristics, school level supports and occupational and educational expectations among rural youth?

Occupational and Educational Expectations in Croatia

In a study on the power of education as a channel for social promotion or as an instrument of life quality change, young people recognized higher levels of education as way to achieve professional progress and future success (Ilišin & Spajić Vrkaš, 2015). Furthermore, the recognition of educational attainment can be observed from the wider sociocultural aspect of transition. The higher education degree is very much valued in Croatian society, and there is apparent trust that scientific institutions and science will ensure a safer, more secure and productive future (Šundalić, 2008). These tendencies can be partly attributed to the educational attainment-related values inherited from the period of socialism, as is the case in other transition countries (Brown & Schafft, 2002). In the 1960s, many citizens had access to secondary and tertiary education. These changes in the educational composition of the population were the result of the number of those attending school after the Second World War (Steinman, 1972). However, strong industrialization led to large migrations from rural to urban areas. These migrations led to problems in urban areas, such as an increase in unemployment. The uncontrolled rural exodus lowered the agricultural population potential; there were no structural transformations in agriculture, and there was an apparent dominance of small and marginal economies. This lack of structural change further weakened the development of agriculture and other branches of the rural economy (Župančić, 1993). The described situation required action in order to establish a better balance of development in rural and urban areas, which has been recorded in many parts of the world *(In this sense, the Education for Rural Development (Atchoarena & Gasperini, 2003) initiative was launched at the global level with the aim of improving the quality of and access to basic education.)* This was particularly important in regard to the significant number of rural areas (almost 80%) in the total land area of the country, where the rural population makes up 56.7% of the total population (Rural Development Program of the Republic of Croatia for the period 2014-2020).

There is a need for development of lifelong learning programs that focus on the needs of people in rural areas. This is directly linked to the development of human potential of rural villages and agriculture, as well as the return of the educated young population to rural areas, while emphasizing quality education in general (Žutinić & Markovina, 2009). Successful approaches to secondary education in Croatia have also increased aspirations towards the attainment of higher education degrees. In recent years, there has been a mass participation of young people in higher education, followed by an increase in the number of highly educated people among the working-age population (Puzić & Košutić, 2015).

Despite these improvements, the share of people that hold a higher education degree in Croatia is still smaller than in most EU countries. This trend is supported by the development of a wider network of higher education institutions. Over the last 15 years, there has been an increase in the availability of higher education access in all Croatian counties. According to the statistical data from 2016, in Croatia there were about 4.2 million inhabitants, and 132 higher education institutions, while 10 years ago, there were 114 higher education institutions (SBS, 2018; SBS, 2008). Most of these institutions are public and have no student tuition fees. After the period of socialism in the 1990s, partial tuition was introduced for a certain quota of students enrolled at universities. This was abolished after strong pressure from the wider public and students themselves, who publicly protested against the commercialization of higher education in 2009 and 2010. In addition to the long-standing policy of encouraging participation in higher education, this tendency is now largely linked to the achievements of the Europe 2020 strategy goals and to the EU's political incentives for new Member State accession (Kahanec, Zaiceva & Zimmermann, 2010). These policies suggest that the share of the population aged 30 to 34 years with higher education degrees will be at least 40% by 2020 (Downes, 2014). According to the European Commission's (2019) statistical data, in Croatia 34.2% of people in this age group hold a higher education degree, with an unusually wide gender gap (41.9% of women versus 26.5% of men).

The options for education in rural areas are unsatisfactory, but it is estimated that leaving the rural environment is mostly related to dissatisfaction with the network of social services and the lack of cultural manifestations. Unemployment and the lack of career opportunities are recognized as among the key issues that trigger departure from the rural community (Žutinić et al., 2010). Therefore, the educational aspirations of young people in rural areas are also marked by these concerns.

In addition, attainment of a higher education degree is one of the primary pathways for the upward social and geographical mobility of young people. Their choices of higher education programs also have sociocultural and geographical impact, with consequences on both the personal (development of personal capital) and social levels (community prosperity and the development of regions) (Klepač, 2016). In other words, for youth in rural areas, it means avoiding some educational choices that are directly linked to leaving the rural environment. Rural schools create human capital that directly facilitates the development of non-rural places elsewhere (Petrin, Schaft & Meece, 2014). The situation in rural Croatia, and in particular on the islands and the coast, does not provide young people with a variety of career choices; the existing job opportunities are available mainly in the primary and tertiary sectors (Babić & Lajić, 2004), including agriculture and service jobs related to the intensive development of tourism over the last decade. Nevertheless, this should not be the reason for leaving rural areas, given that these sectors are also seeking a highly educated population that could, for example, improve agricultural production and develop tourism. It is particularly connected to the present intent of developing agrotourism as a new paradigm for sustainable tourism in rural Croatia (Vrsaljko, Turalija & Grgić, 2017), as well as the increasing focus on healthier living practices as a survival strategy for rural populations (Puđak & Bokan, 2011). In this respect, the first measure of the Rural Development Program of the Republic of Croatia 2014-2020 (NN, 2019) involves support to improve education among the agricultural population, which would impact the socioeconomic development of rural areas and the competitiveness of Croatian agriculture.

Since Croatia's entrance into the EU, young people in Croatia have experienced an increase in opportunities to participate in the common European higher education programs and the European labor market. Related to the labor market crisis in Croatia, it is interesting to see the ways in which young people in rural areas have responded to these challenges. It is possible to observe the role of education; education usually served as the primary justification behind rural migration, which indicates the vicious circle of limited rural opportunities and underdevelopment (Schaft, 2016). In addition, it should be noted that at the beginning of this century, the primary disadvantage of the Croatian education system was the outdated and overloaded curriculum (Lowther, 2004). Hence, in recent years there were initiatives focusing on significant curricular reforms at all levels of education, with an emphasis on elementary school and secondary vocational education.

This primarily involved an adjustment of educational opportunities to meet the needs of specific geographic areas and their economies, such as labor market needs and readiness for lifelong learning (NN, 2018). Likewise, there were some inequalities in access to educational resources that were influenced by sociocultural and geographic conditions and which impacted the aspirations for educational achievement and quality of life in rural areas (Agger, Meece, & Byun, 2018). For example, where a community is located impacts various aspects of education, including barriers and opportunities, emphasizing social links within the local community, schools and family. Schools play a central role in the communication of concerns and potential solutions to stakeholders in relation to schools and their students, and they can contribute to reducing inequities and improving results in the educational process (Stanić, Hren & Buzov, 2016).

School Experiences in terms of School Climate and School Professional Guidance

The high school students' experience is complex and serves as the context for this study; we explore it in relation to school climate and school professional guidance. Studies focusing on school climate emphasize that schools do not exist in isolation and are an intricate system of many parts (Cohen et al., 2009; Batarelo Kokić, Buzov & Bodlović, 2018; Konold et al, 2018; Maxwell et al., 2017; Thapa et al., 2013). The nature of school life is naturally influenced by the district and various community levels (local, state, and national) within which it operates. Cohen et al. (2009) suggested that the school climate is based on patterns of people's experiences of school life and reflects norms, goals, values, interpersonal relationships, teaching and learning practices, and organizational structures. A positive school climate contributes to student participation and greater academic achievement (Thapa et al., 2013; Maxwell et al., 2017), while some research expands the idea of a school climate as a system that influences other aspects of the school and its stakeholders (Konold et al, 2018). School climate refers to the social characteristics of a school in terms of relationships among students and staff/faculty, the emphasis placed on learning and teaching, the values and norms, and shared approaches and practices (Thapa et al., 2013).

Student assessment of teachers' characteristics in island schools differs by the grade students are attending, where first grade students assess teachers with higher mean scores, and scores decrease as the students get older (Batarelo Kokić, Buzov & Bodlović, 2018). According to a study conducted by Maxwell et al. (2017), students' perceptions of the school climate significantly explain writing and numeracy achievement, and the outcomes are mediated by students' psychological identification within the school setting. Additionally, staff perceptions of school climate explain students' achievement on tests of numeracy, writing and reading. Furthermore, Konold et al. (2018) found that a positive school climate leads to more engaged students and results in higher academic performance.

The social and cultural background or context of the community influences the educational and professional aspirations of young people through three main environmental aspects: their local community, the family and school influences. This structural approach is based on the assumption that elements are developed not only in terms of opportunity but that there is also a set of possible constraints and self-conceptual concepts (Furlong & Biggart, 1999). Furthermore, many researchers have emphasized the strength of the relationship between educational achievement and professional aspirations and claimed that secondary school experiences significantly shape students' aspirations (Furlong & Biggart, 1999; Shah, Dwyer & Modood, 2010). Research indicates that students in rural and low-income schools found teachers to be most helpful in regards to information about their futures, compared to students in small-town and higher income schools (Griffin, Hutchins & Meece, 2011). While educational aspirations are largely influenced by parental decisions about their children's education, physical distance from educational institutions also impacts educational choices (Mookherjee, Napel & Ray, 2010). The educational system and schooling opportunities in rural environments should be adjusted to account for the needs of the local economy, and schools and educators play a significant role in the wider processes that are key to the economic development of the community (Petrin, Schafft & Meece, 2014). In addition, local educational opportunities, together with family support, are key factors influencing the aspirations and plans of high school students. In this sense, rural living areas, social conditions or the sociocultural backgrounds of young people, along with personal or family influences, as well as the school climate and school programs, are key factors that influence aspirations (Strand & Winston, 2008; Dupriez et al., 2012).

According to the above literature review, there is an existing gap in our knowledge about the influence of school experiences on rural youth and their occupational and educational expectations.

Given the existing gap, there is value in understanding the ways in which students from the rural areas of southern Croatia see their future, in their community or somewhere else, based on their estimates of the support or influence of family SES, school, educators and opportunities in the community. In the current study, while controlling primary demographic characteristics (i.e. gender, family SES), we conceptualized the school experience factors of school climate and professional guidance at school as mediators between the occupational and educational expectations of rural youth.

Methods

Sample and Procedure

Among 565 high school students (average age M=17.14 years, SD=1.06) who participated in the present study, 44.52% were male and 55.47% female. The participants were attending high school programs in the Split-Dalmatian County and were enrolled in all grades of high school. Participants were recruited at their schools and completed the prepared questionnaires within a group setting. The study was approved by the university's institutional review board and the principal of the school in which the research took place.

Instruments

The survey instrument that was used was adapted from the Rural Youth Aspirations Study (RYAS) that was developed by the National Research Center for Rural Education Support at the University of North Carolina in Chapel Hill (Byun, Meece, Irvin, & Hutchins, 2012; Petrin, Meece, & Schafft 2014). The survey instrument was adapted to the Croatian social and educational context and translated into Croatian. The version we used was first tested in a pilot study to assess, in part, its applicability to a Croatian context. The survey was administered by trained peer researchers.

Data Analysis

Descriptive statistical analysis was conducted to explore the primary features of high school students' views regarding aspirations for a meaningful career in the local area.

A factorial analysis was used to evaluate the influence of individual variables and their interactions.

Correlation and several multiple regression analyses were conducted to analyze the relationship between participants' attitudes towards aspirations of a meaningful career, future preferences in work and family values, school climate, professional guidance at school, gender and SES.

The scales used were translated from English for the purpose of this study and further adjusted to the characteristics of the Croatian school system context.

The *Aspirations for a meaningful career in the local* area scale consisted of 14 items that the participants rated on a 6-point scale, from 1 (strongly disagree) to 6 (strongly agree). An exploratory factor analysis using the principal component extraction method was performed, which indicated the existence of one underlying factor that explained 42.5% of the variance. The possible range of scores on this scale was 14–84; the participants scored an average of 57.8 points (SD=13.8), which indicated moderate agreement with the statements depicting positive opinions regarding local area career opportunities. The reliability of the scale, measured using the Cronbach α coefficient, was .891, indicating a satisfactory level of reliability.

The *Future perspectives scale* consisted of 11 items that the participants rated on a 6-point scale, from 1 (strongly disagree) to 6 (strongly agree). An exploratory factor analysis using the principal component extraction method and varimax rotation was performed, which indicated the existence of two underlying factors that together explained 44.73% of the variance. Five items loaded onto the first factor that explained 24.44% of the variance and was titled family values. The possible range of scores on this subscale was 5–30; the participants in the current study scored an average of 24.98 points (SD=4.28), which indicated a high level of agreement with the statements that showed positive family values attitudes The reliability of this subscale, measured using the Cronbach α coefficient, was .704. The second factor explained the remaining 20.28% of the variance and was titled employment goals. The possible range of scores on this subscale was 6–36; the participants in the current study scored an average of 33.30 points (SD=5.2), which indicated a high level of agreement with the statements showing positive attitudes towards employment goals. The reliability of this subscale, measured using the Cronbach α coefficient, was .614, indicating a satisfactory, though modest, level of reliability.

The *School climate scale* consisted of 11 items that the participants rated on a 6-point scale, from 1 (strongly disagree) to 6 (strongly agree).

Exploratory factor analysis using the principal component extraction method was performed, which indicated the existence of one underlying factor that explained 50.4% of the variance.

The possible range of scores on this scale was 11–66; the participants scored an average of 35.5 points (SD=9.9), which indicated a low level of agreement with statements showing positive opinions regarding the school climate.

The reliability of the scale, measured using the Cronbach α coefficient, was .899, indicating a satisfactory level of reliability. The *Professional guidance at school scale* consisted of 18 items that the participants rated on a 6-point scale, from 1 (strongly disagree) to 6 (strongly agree). Exploratory factor analysis using the principal component extraction method was performed, which indicated the existence of one underlying factor that explained 35.64% of the variance. The possible range of scores on this scale was 18–108; the participants in the current study scored an average of 31.31 points (SD=10.25), which indicated minimal agreement with statements expressing positive experiences with professional guidance. The reliability of the scale, measured using the Cronbach α coefficient, was .884, indicating a satisfactory level of reliability.

Results

Correlation analysis was the first step in investigating the relationships among the explored variables (Table 1). Results indicated a positive correlation between school climate and participants' aspirations for a meaningful career, future family values and future employment goals. Moreover, there is a positive correlation between professional guidance at school and participants' aspirations for a meaningful career, future family values and future employment goals. Furthermore, positive correlations between the participants' aspirations for a meaningful career, future family values and future employment goals were found. Finally, there is a positive correlation between the participants' aspirations for a meaningful career, gender and family SES.

Table 1: Correlation matrix for the tested variables

	v1	**v2**	**v3**	**v4**	**v5**	**v6**	**v7**
Gender (v1)	-	.036	.145**	.134**	.141**	.073	.097*
Family SES (v2)		-	.061	.219**	.127**	.003	.066
School climate (v3)			-	.463**	.238**	.222**	.237**
Professional guidance at school (v4)				-	.280**	.165**	.169**
Aspirations for a meaningful career					-	.329**	.395**
Future: family values (v6)						-	.494**
Future: employment goals (v7)							-

*p<.05; **p<.01

Next, in order to investigate the relative contributions of different demographic characteristics and school level supports to participants' attitudes towards aspirations for a meaningful career in the local area and preferences towards future family values and future employment goals, a hierarchical regression analysis was used. The analysis was performed using two demographic characteristics (gender and family SES) and school level support characteristics (school climate and professional guidance at school) as predictors. In the first step, gender and family SES were entered as predictors. In the second step, school climate and professional guidance at school were entered as the final potential predictors for the selected criterion (Table 2).

Results revealed that gender, school climate and professional guidance at school were significant predictors of aspirations for a meaningful career among rural youth (see Table 2). Results of regression analysis for aspirations for a meaningful career show that selected predictors explain a small percentage of the variance (approximately 10%), while the impact for the full-model is small (Cohen's f2=0.10; Cohen, 1988). Demographic characteristics explain 2% of variance with minor impact (Cohen's f2=0.03), while school level supports (school climate and professional guidance at school) do contribute, with 6% variance and a small impact (Cohen's f2=0.07) on aspirations for a meaningful career among rural youth.

Table 2: Results of Hierarchical Regression Analysis using Opinions towards a Meaningful Career, Family Values and Employment Goals as the Criterion

Criterion	**Aspirations for a Meaningful Career**	**Future: Family Values**	**Future: Employment Goals**
Predictors	β	β	β
Gender	.136**	.073	.094*
Family SES	.122**	.000	.063
Regression model	R=0.186; R^2=0.035; R^2_{adj}=0.031; $F_{(2,562)}$=10.079, p<0.000; Cohen's f^2=0.03	R=0.073; R^2=0.005; R^2_{adj}=0.002; $F_{(2,562)}$=1.523, p>0.05; Cohen's f^2=0.01	R=0.115; R^2=0.013; R^2_{adj}=0.010; $F_{(2,562)}$=3.785, p<0.05; Cohen's f^2=0.012
Gender	.093**	.037	.058
Family SES	.073	-.028	.039
School climate	.131**	.179**	.198**
Professional guidance at school	.191**	.083	.061
Regression model (final solution)	R=0.327; R^2=0.107; R^2_{adj}=0.101; $F_{(4,560)}$ =16.815, p<0.000; ΔR^2=0.073; Cohen's f^2=0.07 Cohen's f^2= 0.10 (full-model)	R=0.237; R^2=0.056; R^2_{adj}=0.049; $F_{(4,560)}$ =8.325, p<0.000; ΔR^2=0.051; Cohen's f^2=0.05 Cohen's f^{2d}= 0.06 (full-model)	R=0.256; R^2=0.066; R^2_{adj}=0.059; $F_{(4,560)}$ =9.838, p<0.000; ΔR^2=0.052; Cohen's f^2=0.03 Cohen's f^2= 0.061 (full-model)

** p< 0,01; * p<0,05

In the first hierarchical regression analysis, we used aspirations for a meaningful career as the criterion.

In the second hierarchical regression analysis, we used future family values as the criterion. Results revealed that professional guidance at school was the only significant predictor of preferences towards future family orientation among rural youth (see Table 2). Results of regression analysis for preferences towards future family orientation show that selected predictors explain a small percentage of the variance (approximately 6%), while the impact for the full-model is small (Cohen's f2=0.06). Demographic characteristics explain 1% of variance with minor impact (Cohen's f2=0.01), while school level supports (school climate and professional guidance at school) do contribute, with 5% variance and a small impact (Cohen's f2=0.05) on preferences towards future family orientation among rural youth.

In the third hierarchical regression analysis, we used future employment goals as the criterion.

Results revealed that professional guidance at school was the only significant predictor of preferences towards future employment goals among rural youth (see Table 2). Results of regression analysis for preferences towards future employment goals show that selected predictors explain a small percentage of the variance (approximately 6%), while the impact for the full-model is small (Cohen's f2=0.061). Demographic characteristics explain 2% of variance with minor impact (Cohen's f2=0.012), while school level supports (school climate and professional guidance at school) do contribute, with 4% variance and a small impact (Cohen's f2=0.03) on preferences towards future family orientation among rural youth.

Discussion

The first research question focuses on the levels of perceived attitudes towards the school climate, school professional guidance, aspirations for a meaningful career and future perspectives among rural youth.

Relatively high average points on the family values subscale and visibly lower scores on the school climate and the professional guidance scale are supported by other recent research studies. In a survey by Baranović et al. (2015), the findings indicated nearly the same distribution for the influence of parents, brothers, friends, teachers and school staff on the educational and career plans of high school students. In our case, this may be related to the rural location, which often includes a lack of school counselors or less access to school counselors, and is less likely to be included in post high school graduation preparation activities, like visiting college campuses and career research, as already noted in similar research (Griffin, Hutchins & Meece, 2011). These data point to the need to improve or establish school counseling in Croatian schools, especially in rural areas. The scores on the professional guidance scale indicated that there was no adequate informational support on career opportunities in local area schools.

The second and third research question focused on the presence and direction of any relationship between demographic characteristics, school level supports and occupational and educational expectations among rural youth. The correlation analysis results indicate the presence of an association between demographic characteristics, school level supports, career aspirations and future family and employment expectations of rural youth. Furthermore, the results of regression analysis clearly indicate that the school climate does influence aspirations towards meaningful career, future family orientation and future employment goals.

In addition, aspirations towards a meaningful career are also influenced by professional guidance at school and gender.

These study findings can be related to those from previous research. Research on implementation of curriculum strategies focusing on career development among high school students in rural areas helped students attain critical knowledge of career development, enhanced their satisfaction with school and prepared them to achieve future educational and career goals (Lapan, Tucker, Kim & Kosciulek, 2003). These results can also be interpreted in relation to the importance of implementation of entrepreneurial competences in the vocational education curriculum; additionally, the current curriculum may not be in alignment with the needs of the economy and the labor market (Bohuš & Pavelić, 2011). Sustainable development of a lifelong entrepreneurial learning system requires focus on all levels of formal education within the Croatian education system (Ljubić, Heder & Batarelo Kokić, 2013).

In this context, it is important to note that many vocational education students aspire to complete the state matriculation and then enroll in higher education (Matković et al., 2013). In one of the most comprehensive youth surveys including young people that are still in school and those that recently completed their education, the participants were asked about desirable education paths, and only 23% of them selected secondary education vocational schools, while others selected tertiary education (Ilišin et al., 2013). Students have preconceived ideas that vocational education is for lower academic achievers, so that they would benefit from opportunities to experience tangible vocational occupations in practice (Hargreaves & Osborne, 2017). In this respect, there is a need for more comprehensive linking of teaching content with practical work, as well as the adaptation of teaching topics to the needs of everyday life (Ilišin & Spajić Vrkaš, 2015).

In interpreting the results of this study, one should keep in mind factors that could limit the generalizability of the results. As part of the survey study findings, the main issues were analyzed in relation to the educational and professional aspirations of rural youth, influenced by the family, the school environment and the rural community. Nevertheless, it should be noted that the survey participants lived in rural areas near a major urban center, with a developed transportation network and significant career opportunities in the urban area.

Conclusion

This study of the educational and professional aspirations of young people from rural areas in southern Croatia offers insight into the future potential trajectory of lifelong learning and future careers. The relatively high percentage of youth planning to leave the local community in Croatia has created several issues regarding the intersection of and disaggregation between education and the existing potential for development of these rural communities. Although students believe that education is important and they express aspirations towards higher education achievements, at the same time they feel their education and training has major disadvantages in relation to an unsustainable labor market compensation. Our results also point to previous conclusions indicating that pupils in developing countries, such as Croatia, have a tendency to idealize higher education, owing to lower quality and inefficiency of the educational systems (Lavrič, 2015). This finding can be linked to the mismatch between the skills students acquire at the secondary school level and labor market demands (Bartlett, 2013).

Related to that, the National Strategy for the Education of Science and Technology of the Republic of Croatia (NN, 2014) and the National Youth Program (MSPM, 2014) predict curricular reform of formal education, with an emphasis on the development of key competences related to a multifunctional set of knowledge, skills and attitudes necessary for personal development, social inclusion and employment. Special emphasis is placed on cooperation between schools/universities and employers. In that sense, it would be useful to harmonize high school educational programs by encouraging an adaptive and collaborative emphasis on the needs of the local/rural or regional economy--particularly because it is evident that youth want to leave the community or region with the goal of higher educational achievement, but eventually, they want to return. They express that leaving can be interpreted as a confrontation with the apparent reality that moving up means moving out (Hektner, 1995). However, a significant obstacle to the occupational expectations of youth is related to the perceived inadequacy of the education system, lack of practical skills and limited contact with work environments (OECD, 2012).

On the other hand, the results of this study indicated that employment goals are significantly influenced by school climate, which means that such goals can operate through school. Therefore, curricular changes should enable professional guidance/counseling that would involve community connectivity.

Because the attitudes of high school students towards the school climate are strongly related to the determinants of a quality career and associated with their preferences towards future family values, these are significant predictors of future employment goals. Thus, the impact of the social context on professional expectations and the potential for employment in the local community can primarily be reduced to the conditions of formal education, which should be oriented toward the possibility of understanding the availability of community resources. Numerous questions about the challenges of improving education, apart from the new and more open curriculum, can be summarized in one question: What can Croatian schools do for the aspirations of young people? According to the results of our research, there should be a focus on school autonomy and support for the development of regional vocational centers linked to the interweaved connection of work and education, as announced in The Strategy for Education, Science and Technology (NN, 2014). Under conditions of financial decentralization, schools with more autonomy could better respond to the needs of the rural community and accommodate student needs in a timelier manner and with more flexibility.

Nevertheless, this study raises important questions about school choice in rural areas, where schools often face additional challenges, such as more frequent changes of teachers.

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REVIJA ZA ELEMENTARNO IZOBRAŽEVANJE
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OCENJEVANJE TEMPERAMENTA V ZGODNJEM MLADOSTNIŠTVU: PSIHOMETRIČNE ZNAČILNOSTI VPRAŠALNIKA EATQ-R-SF

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Namen raziskave je preveriti psihometrične značilnosti kratke različice revidiranega Vprašalnika temperamenta za zgodnje mladostnike – EATQ-R-SF. Na vzorcu 238 slovenskih zgodnjih mladostnikov smo preverili faktorsko strukturo, zanesljivost ter razlike med spoloma v ravni izraznosti temperamentnih potez. Analiza podatkov je v splošnem pokazala zadovoljivo prileganje podatkov obravnavanim modelom, čeprav indeksi prileganja za nekatere podlestvice niso dosegli priporočenih vrednosti. Skladnost nadrednih lestvic je zadovoljiva. Mladostnice imajo bolj izražene poteze *zadovoljstvo ob šibkih dražljajih*, *strah* in *povezovanje z drugimi* ter dimenzijo *pozitivno čustvovanje* kot mladostniki. EATQ-R-SF je ustrezna za uporabo v raziskovanju, čeprav rezultati nakazujejo potrebo po vsebinskem in psihometričnem izboljšanju pripomočka. **Measurement of Early Adolescents' Temperament: Psychometric Characteristics of the EATQ-R-SF** The study explored the psychometric characteristics of the Revised Early Adolescent Temperament Questionnaire (EATQ-R-SF). Based on data of 238 early adolescents, we examined the factor structure of the EATQ-R-SF, reliability, and gender differences in mean levels of trait scores. The results showed a satisfactory fit to the models, although the fit indices for some subscales did not reach the recommended values. Internal consistency of the scales was satisfactory. Girls exhibited higher levels of *fear*, *pleasure sensitivity, affiliation* and *positive emotionality* than boys. The reliability of scores was appropriate for use in research, although it would need further improvement.

Ključne besede:
temperament, zgodnje mladostništvo, vprašalnik EATQ-R-SF, psihometrične značilnosti, razlike med spoloma.

Keywords:
temperament, early adolescence, questionnaire EATQ-R-SF, psychometric properties, gender differences.

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Uvod

Preučevanje temperamentnih potez ima osrednji pomen v razumevanju posameznikovih osebnostnih značilnosti (Rothbart, Ahadi in Evans, 2000), socialnega vedenja (Wang, Eisenberg, Valiente in Spinrad, 2016), boljšega prilagajanja na zahteve šolskega okolja in prilagojenih učnih izidov (npr. učna uspešnost ter učna motivacija) (Elliot in Thrash, 2002; Else-Quest, Hyde, Goldsmith in Van Hulle, 2006). Za ocenjevanje neposrednih in posrednih učinkov temperamentnih potez na psihosocialne ter učne izide je treba uporabiti zanesljive, časovne stabilne in veljavne merske pripomočke, s pomočjo katerih starši/skrbniki, vzgojitelji ali učitelji ocenijo izraženost otrokovih temperamentnih potez (Rothbart in Bates, 2006). Pri zgodnjih mladostnikih pa lahko ob poročilu staršev ali učiteljev uporabimo tudi samoocenjevalno obliko vprašalnika, preko katere mladostniki poročajo o različnih vidikih svojega vedenja ter čustvovanja (Rothbart in Bates, 2006; Zentner in Bates, 2008). Razvojne značilnosti zgodnjih mladostnikov namreč omogočajo samostojno poročanje o njihovih izkušnjah in prepoznavanje lastnih čustvenih stanj, kar prispeva k bolj veljavnemu ter zanesljivemu ocenjevanju vloge temperamenta v zgoraj navedenih izidih posameznikov (Capaldi in Rothbart, 1992). Danes najbolj uveljavljena konceptualizacija temperamenta izhaja iz dela raziskovalke Rothbart in njenih sodelavcev (npr. Rothbart, 1981; Rothbart in Bates, 2006), ki opredeljujejo temperament kot razmeroma stabilne medosebne razlike v odzivnosti in samouravnavanju, ki jih opazimo že v obdobju dojenčka in malčka, imajo biološko osnovo ter ustrezno pojasnjujejo vedenjske izide (Zupančič, 2016, 2020). Pri tem so medosebne razlike v odzivnosti posameznikov pogojene z razlikami v njihovem vedenjskem in čustvenem sistemu, ki se nenehno spreminjata zaradi sprememb v okolju, k razlikam v odzivnosti pa prispevajo vedenjski procesi, povezani s samouravnavanjem, kot so približevanje, izogibanje, zaviranje in/ali usmerjanje pozornosti (Rothbart in Bates, 2006). Prvotno zastavljen psihobiološki model temperamenta Rothbart (1981) je bil omejen na razvoj temperamentnih potez dojenčkov in malčkov, kasneje pa so ga avtorica in sodelavci v ZDA razširili na kasnejša razvojna obdobja otroštva, mladostništva in odraslosti (Evans in Rothbart, 2007; Putnam, Garstein in Rothbart 2006; Putnam, Jacobs, Gartstein in Rothbart, 2010; Putnam in Rothbart, 2006).

Analiza psihometričnih značilnosti merskih pripomočkov za ocenjevanje temperamenta v posameznih razvojnih obdobjih je pripeljala do ugotovitve, da struktura temperamenta v vsakem izmed razvojnih obdobij pokriva več specifičnih temperamentnih potez, ki se hierarhično združujejo v tri nadredne (robustne) dimenzije temperamenta: *živahnost, negativno čustvovanje* in *prizadevni nadzor* (Ellis in Rothbart, 2001; Putnam idr., 2006; Rothbart in Bates, 2006; Simonds, 2006). Analiza strukture temperamenta je v srednjem otroštvu pokazala še četrto nadredno potezo *družabnost/pripadnost* (tj. otrokova želja po bližini z drugimi; Simonds, 2006), v mladostništvu *povezanost* (tj. intimnost, povezovanje in odzivnost v medosebnih odnosih; Ellis in Rothbart, 2001) in odraslosti *usmerjeno občutljivost* (tj. zaznavanje šibkih dražljajev v okolju s pridruženo čustveno sestavino; Evans in Rothbart, 2007). Temperamentna dimenzija *živahnost* predstavlja posameznikove težnje k doživljanju pozitivnih čustev ter približevanju socialnemu okolju (Ellis in Rothbart, 2001; Shiner in DeYoung, 2013). V zgodnjem mladostništvu odraža medosebne razlike v iskanju dražljajev (Capaldi in Rothbart, 1992) in vključuje specifične poteze *zadovoljstvo ob močnih dražljajih* (tj. zadovoljstvo ob izvajanju dejavnosti, ki vključujejo visoko intenzivnost ali novost), odsotnost *strahu* (tj. čustvo, povezano s pričakovanjem stiske ali bolečine) in odsotnost *socialne plašnosti* (tj. vedenjska zavrtost, zadržanost v medosebnih situacijah) (Ellis in Rothbart, 2001). *Živahnost* se povezuje tako s pozitivnimi kot negativnimi psihosocialnimi izidi otrok in mladostnikov, kot sta nižja raven težav ponotranjenja (npr. tesnobnost, depresivnost, somatske težave) in višja raven težav pozunanjenja (npr. agresivno in tvegano vedenje, vandalizem) (Oldehinkel, Hartman, De Winter, Veenstra in Ormel, 2004; Wang idr., 2016) ter predstavlja biološko podstat osebnostne poteze ekstravertnost (Rothbart idr., 2000). *Negativno čustvovanje* kot temperamentno dimenzijo opredeljuje težnja posameznika k izražanju strahu, jeze, žalosti ali drugih oblik psihološkega distresa in se konceptualno prekriva z osebnostno lastnostjo *nevroticizem* (Clark in Watson, 2008; Shiner in DeYoung, 2013). *Negativno čustvovanje* odraža medosebne razlike v moči negativnih čustev in načinih spoprijemanja z njimi: posamezniki z visoko izraženim negativnim čustvovanjem so v splošnem bolj občutljivi za neugodne učinke okolja in se težko soočajo z razočaranji (Rothbart, Ahadi, Hershey in Fisher, 2001).

V zgodnjem mladostništvu negativno čustvovanje vključuje specifične temperamente poteze *frustracija/vznemirjenost* (tj. negativno čustvovanje, povezano z blokado ciljev ali prekinitvijo dejavnosti), *depresivno razpoloženje* (tj. upad razpoloženja, izguba zadovoljstva in zanimanja za dejavnosti) in *agresivnost* (tj. sovražno in agresivno vedenje, usmerjeno proti predmetu ali osebi, neposredno in posredno besedno nasilje, sovražni odzivi) (Ellis in Rothbart, 2001). Negativno čustvovanje, negativno razpoloženje, izguba zanimanja in veselja v dejavnostih se pri zgodnjih mladostnikih povezujejo s težavami ponotranjenja (Muris, Meesters in Blijlevens, 2007; Wang idr., 2016), medtem ko se sovražno in agresivno vedenje povezujeta s težavami pozunanjenja (Nigg, 2006).

Prizadevni nadzor se pri otrocih in mladostnikih nanaša na sposobnost ohranjanja pozornosti, vztrajanja pri nalogah in doživljanja zadovoljstva ob šibkih dražljajih ter se konceptualno prekriva z osebnostno lastnostjo vestnost (Rothbart in Bates, 2006; Shiner in DeYoung, 2013). *Prizadevni nadzor* deluje pod vplivom izvršilnih funkcij, ki posamezniku omogočajo zavreti prvotni impulz in izbrati situacijsko ustreznejšega (Clark in Watson, 2008). V zgodnjem mladostništvu vključuje specifične poteze *inhibitorni nadzor* (tj. sposobnost zavreti neprimeren odziv ali dejanje), *nadzor dejavnosti* (tj. sposobnost izvedbe izbranega dejanja, kljub močni težnji po izogibanju le temu) in *pozornost* (tj. sposobnost usmerjanja pozornosti ali preusmerjanja pozornosti z enega objekta ali naloge na drugega oziroma drugo). *Prizadevni nadzor* ima pomembno vlogo v psihosocialnem razvoju mladostnikov; nizka raven sposobnosti odloga zadovoljitve se skupaj z negativnim čustvovanjem povezuje s težavami pozunanjenja, kot sta agresivno ter prestopniško vedenje (Clark, Donnellan, Robins in Conger, 2016; Ellis, 2002).

V strukturi temperamenta zgodnjih mladostnikov se je v ZDA pokazala še četrta splošna temperamentna dimenzija, tj. *povezanost*. Nanaša se na vedenjske vzorce čustvene komunikacije, intimnosti in odzivnost v medosebnih odnosih. Vključuje specifične temperamentne poteze *povezovanje z drugimi* (tj. želja po bližini z drugimi, naklonjenih medosebnih odnosih, neodvisno od družabnosti in plašnosti), *zaznavna občutljivost* (tj. zaznava šibkih, komaj opaznih dražljajev v okolju, neodvisno od zaznavnih sposobnosti) in *zadovoljstvo ob šibkih dražljajih* (tj. količina zadovoljstva, ki je povezana z dejavnostmi nizke intenzitete, ravni, zapletenosti in novosti). *Povezanost* ima pomembno vlogo še posebej v vrstniških in ljubezenskih odnosih (Ellis in Rothbart, 2001).

Rezultati preteklih raziskav (npr. Ellis in Rothbart, 2001; Else-Quest idr., 2006; Muris in Meesters, 2009; Sooyeon, Brody in Murry, 2003) so podprli pomembne razlike v ravni izraženosti specifičnih temperamentnih potez in nadrednih dimenzij med zgodnjimi mladostniki in mladostnicami. Mladostnice v splošnem poročajo o višji ravni *povezovanja z drugimi, strahu, zadovoljstva ob šibkih dražljajih* in *socialne plašnosti*, medtem ko mladostniki poročajo o višji *ravni dejavnosti* in *zadovoljstvu ob močnih dražljajih* (Muris in Meesters, 2009). Za mladostnice je značilno tudi učinkovitejše *uravnavanje pozornosti* (Sooyeon idr., 2003), inhibitornega nadzora (Else-Quest idr., 2006) in *nadzora dejavnosti* (Muris in Meesters, 2009). Majhne do zmerne razlike med spoloma se pojavljajo še pri *zaznavni občutljivosti*, ki je višje izražena pri mladostnicah. Po mnenju razvojne psihologinje Else-Quest in sodelavcev (2006) mladostnice ustrezneje zaznajo šibke dražljaje in se močneje zavedajo subtilnih sprememb v okolju kot mladostniki. Podobno kažejo izsledki sodobnih raziskav temperamenta zgodnjih mladostnikov; španske mladostnice so izražale višjo raven *povezovanja z drugimi, zadovoljstva ob nizko intenzivnih dražljajih, socialne plašnosti* in *nadzora dejavnosti*, medtem ko so mladostniki poročali o v višji ravni *zadovoljstva ob močnih dražljajih* (Viñas, González, Gras, Jane in Casas, 2015). Tudi rezultati raziskave s kitajskimi zgodnjimi mladostniki so pokazali višjo izraznost *prizadevnega nadzora, povezanosti, negativnega čustvovanja* in *socialne plašnosti* pri mladostnicah ter višjo izraznost *živahnosti* in *agresivnosti* pri mladostnikih (Zhang, Shen in Gao, 2008). Kljub pomembnim razlikam med spoloma v izraznosti specifičnih temperamentnih potez pa so te majhne in nedosledne. Na podlagi nedoslednih ugotovitev raziskovalci predlagajo preučevanje spola kot moderatorske spremenljivke v odnosu med temperamentom in psihosocialnimi izidi. Tako je lahko v kontekstu interakcij posameznikov z vrstniki istega spola povezanost med prizadevnim nadzorom in socialno kompetentnostjo v izobraževalnem kontekstu različna za mladostnice in mladostnike. Nižja raven prizadevnega nadzora je, recimo, lahko problematična za razvoj socialne kompetentnosti; pri tem so učinki za fante odvisni od njihovih medosebnih interakcij v vrstniški skupini ter se pogosto povezujejo z dominantnimi in agresivnimi vedenjskimi vzorci. Pri dekletih pa prizadevni nadzor spodbuja socialno kompetentnost, ne glede na spolno sestavo njihove vrstniške skupine (npr. Fabes, Martin, Hanish, Anders in Madden-Derdich, 2003).

Za namene ocenjevanja izraznosti specifičnih potez in nadrednih dimenzij temperamenta so raziskovalci v ZDA za razvojno obdobje zgodnjega mladostništva razvili Vprašalnik temperamenta za zgodnje mladostnike (ang. *Early Adolescent Temperament Questionnaire*; EATQ; Capaldi in Rothbart, 1992), ki je bil kasneje revidiran z namenom bolj zanesljivega ocenjevanja temperamentnih značilnosti (Ellis in Rothbart, 2001). Vprašalnik EATQ-R-SF v naboru merskih pripomočkov za ocenjevanje temperamenta v različnih razvojnih obdobjih predstavlja prvo obliko samoocene in pomembno dopolnilo starševski ali učiteljevi oceni mladostnikovih temperamentnih značilnosti.

Namen

V Sloveniji je bila za ocenjevanje temperamenta prevedena, prilagojena in v literaturi dokumentirana zgolj kratka različica Vprašalnika o vedenju malčkov (ang. *The Early Childhood Behavior Questionnaire – Short Form*; ECBQ-SF; Putnam idr., 2010), ki se je izkazala kot zanesljiva mera malčkovega temperamenta (Stropnik in Zupančič, 2014). Čeprav so se vprašalniki za ocenjevanje temperamentih potez v kasnejših razvojnih obdobjih (npr. srednje otroštvo, zgodnje mladostništvo) v prevodu že uporabili pri nas, njihove merske značilnosti niso bile sistematično raziskane. Namen pričujoče raziskave je preveriti psihometrične značilnosti kratke različice Vprašalnika temperamenta za zgodnje mladostnike (ang. *Early Adolescent Temperament Questionnaire – Revised – Short Form*; EATQ-R-SF; Ellis in Rothbart, 2001). EATQ-R-SF smo v soglasju z avtoricama prevedli in prilagodili za slovensko jezikovno ter kulturno okolje. Z uporabo konfirmatornega pristopa smo želeli preveriti faktorsko strukturo EATQ-R-SF in notranjo zanesljivost posameznih temperamentnih podlestvic ter nadrednih dimenzij. Pričakovali smo, da bomo štiridimenzionalno strukturo z 12 specifičnimi faktorji podprli tudi pri slovenskih zgodnjih mladostnikih. Nadalje smo želeli preveriti razlike med spoloma v izraznosti specifičnih potez in nadrednih temperamentnih dimenzij. Pri tem smo predpostavili, da se bodo mladostnice višje ocenile pri potezah (podlestvicah) *povezovanje z drugimi, strah, zadovoljstvo ob šibkih dražljajih, zaznavna občutljivost* in *socialna plašnost* ter pri dimenzijah *povezanost* in *prizadevni nadzor*, medtem ko se bodo mladostniki višje ocenili pri potezi (podlestvici) *zadovoljstvo ob močnih dražljajih* in dimenziji *živahnost*.

Metoda

Vzorec

Vzorec vključuje 238 zgodnjih mladostnikov, ki so v času raziskave obiskovali 6., 7. ali 8. razred osnovnih šol iz Podravske in Pomurske regije. Stari so bili od 11 let in 5 mesecev do 14 let in 6 mesecev (M = 12,4 let, SD = 8 mesecev), deklet je bilo 128 (53,8 %) in fantov 110 (46,2 %).

Pripomoček

Vprašalnik temperamenta za zgodnje mladostnike – kratka oblika (EATQ-R-SF; Ellis in Rothbart, 2001) vključuje 65 postavk, ki se nanašajo na različne značilnosti temperamenta, na primer živahnost, pozornost, različne vrste čustvovanja, zaznavno občutljivost in podobno. Avtorici navajata, da se pri vzorcih mladostnikov v ZDA postavke združujejo v 12 podlestvic, na podlagi katerih lahko sklepamo na raven izraznosti specifičnih temperamentnih potez (*zadovoljstvo ob močnih dražljajih, strah* (obratno vrednotenje), *socialna plašnost* (obratno vrednotenje), *depresivno razpoloženje, frustracija/vznemirjenost, agresivnost, inhibitorni nadzor, pozornost, nadzor dejavnosti, zadovoljstvo ob šibkih dražljajih, zaznavna občutljivost, povezovanje z drugimi*). Podlestvice se dalje združujejo v štiri nadredne temperamentne dimenzije: *živahnost*, *negativno čustvovanje, prizadevni nadzor* in *povezanost*. Mladostniki na postavke odgovarjajo s pomočjo 5-stopenjske lestvice pogostosti, pri čemer 1 pomeni »skoraj nikoli ne drži zame« in 5 »skoraj vedno drži zame«. Določene postavke vrednotimo obrnjeno. Skupni dosežek pri posamezni podlestvici predstavlja povprečno vrednost odgovorov na postavke, ki sestavljajo podlestvico. (Če udeleženec izpusti določeno postavko, jo izpustimo iz izračuna povprečja.) Skupni dosežek pri vsaki nadredni temperamentni dimenziji predstavlja povprečje vsote rezultatov pri pripadajočih podlestvicah. Rezultat pri podlestvicah strah in socialna plašnost (nadredna dimenzija živahnost) vrednotimo obrnjeno. EATQ-R-SF se je v izvirni raziskavi pokazal kot primerno notranje zanesljiv, pri čemer koeficienti alfa za merjenje zanesljivosti dimenzij znašajo med 0,65 in 0,82 (Ellis in Rothbart, 2001). Prevod in priredbo vprašalnika smo opravili na Oddelku za psihologijo Filozofske fakultete Univerze v Ljubljani.

Postopek

Pričujoča raziskava je bila odobrena s strani Komisije za etiko Filozofske fakultete Univerze v Ljubljani (št. odločbe 153-2019, 4. 3. 2019). S postopkom dvojnega prevoda v slovenščino in vzvratnim prevodom smo želeli zagotoviti vsebinsko enakost z izvirnim EATQ-R-SF. Prevod vprašalnika sta neodvisno izvedli dve psihologinji, vzvratni prevod pa je opravila psihologinja, ki deluje v angleško govoreči državi. Prevod smo primerjali z izvirnim EATQ-R-SF in uskladili majhna vsebinska neskladja. Pred izvedbo raziskave smo pri petih zgodnjih mladostnikih individualno preverili razumevanje trditev. Posamezno trditev smo mladostniku prebrali, preverili jasnost in razumljivost ter ga prosili, da jo razloži s svojimi besedami. Na podlagi pridobljenih opažanj smo pripravili končno različico vprašalnika. Priprava na izvedbo raziskave in zbiranje podatkov na petih osnovnih šolah Podravske in Pomurske regije sta potekala v prvi polovici leta 2019. Po pridobljenem soglasju osnovnih šol za sodelovanje smo učencem 6., 7. in 8. razreda razdelili obveščena soglasja za starše. V raziskavo smo vključili zgodnje mladostnike s pridobljenim informiranim soglasjem staršev za sodelovanje, sočasno pa smo pridobili tudi ustno soglasje mladostnikov. Sodelujoči mladostniki so vprašalnike izpolnjevali med razredno uro v obliki papir-svinčnik, za kar so potrebovali približno 15 minut, zagotovili smo jim tudi anonimnost.

Statistična obdelava podatkov

Analizo podatkov smo izvedli s pomočjo programov IBM SPSS 22.0 in Mplus 8.0 (Muthén in Muthén, 1998–2017). Na osnovi odgovorov na postavke smo izračunali dosežke pri 12 podlestvicah (specifičnih temperamentnih potezah), te smo pa v nadaljnjem koraku združili v štiri hierarhično nadredne temperamentne dimenzije. V statističnem programu IBM SPSS 22.0 smo preverili normalnost porazdelitve vseh podlestvic in izračunali opisne statistike. Konfirmatorno faktorsko analizo (KFA) smo izvedli v programu Mplus 8 (Muthén in Muthén, 1998–2017) z uporabo MLR (ang. *Maximum Likelihood: Robust Standard Errors*) cenilke parametrov, ki je v Mplusu privzeta cenilka za podatke, katerih porazdelitev odstopa od normalne. Pri odločanju o ustreznosti prileganja modelov smo uporabili mere $\chi 2$, RMSEA (ang. *Root Mean Square Error of Approximation*), CFI (ang. *Comparative Fit Index*) in TLI (ang. *Tucker Lewis Index*) s sledečimi mejnimi vrednostmi: RMSEA < 0,06; CFI in TLI > (ali blizu) 0,95 (Hu in Bentler, 1999). Zanesljivost specifičnih temperamentnih podlestvic in nadrednih dimenzij smo ocenili z McDonaldovim koeficientom omega (ω) in

Cronbachovim koeficientom zanesljivosti alfa (α). McDonaldov koeficient omega smo izračunali v programu JASP 0.11.1.0. Manjkajoče vrednosti so se pojavile pri 17 % udeležencev, vendar je bil delež manjkajočih podatkov nižji od 10 %, zaradi česar nismo izločili nobenega udeleženca iz nadaljnjih analiz. Navedene statistične analize smo izvedli s podatki 238 mladostnikov (na ravni značilnosti α = 5 %).

Rezultati

Konfirmatorna faktorska analiza

S konfirmatorno faktorsko analizo drugega reda (KFA) smo preverili pripadnost merjenih spremenljivk obravnavanim konstruktom. Podatki slovenskega vzorca zgodnjih mladostnikov se niso zadovoljivo prilegali predpostavljenemu štirifaktorskemu modelu temperamenta (Ellis, 2002) ($\chi2$ (48) = 298,32; p = 0,000; RMSEA = 0,148, 90 % IZ [0,132–0,164]; CFI = 0,63; TLI = 0,49). Zaradi negativne rezidualne variance spremenljivke *pozornost*, smo varianco te spremenljivke fiksirali na 0 (Byrne, 2012) in ponovno izvedli KFA. Tudi ta model je statistično pomembno odstopal od podatkov ($\chi2$ (49) = 292,63; p = 0,000), pomembne razlike v izboljšanju indeksov prileganja ni bilo moč opaziti: RMSEA = 0,145, 90 % IZ [0,129–0,161]; CFI = 0,64; TLI = 0,51. Standardizirane faktorske uteži (λ) so v povprečju znašale od 0,25 do 0,71, pri čemer so bile problematične predvsem nasičenosti spremenljivk *socialna plašnost* (obratno vrednoteno; M(λ) = 0,13); *agresivnost* (M(λ) = 0,09); *inhibitorni nadzor*, (M(λ) = 0,09) in *zadovoljstvo ob močnih dražljajih* (M(λ) = 0,01). Zaradi nezadovoljivega prileganja štirifaktorskega modela podatkom, ki je lahko posledica drugačne faktorske strukture ali nizke zanesljivosti posameznih spremenljivk (Sooyeon idr., 2003), smo nekoliko drugače razvrstili podlestvice EATQ-R-SF v tri nadredne temperamentne dimenzije, tj. kot ga je avtorica vprašalnika priporočila pet let po objavi revidirane oblike EATQ (Ellis, 2007, v Snyder idr., 2015). Struktura temperamenta zgodnjih mladostnikov naj bi tako vključevala tri nadredne temperamentne dimenzije z 11 specifičnimi potezami (podlestvicami): *prizadevni nadzor* (vključuje podlestvice *pozornost, nadzor dejavnosti* in *inhibitorni nadzor*), *negativno čustvovanje* (tvorijo ga podlestvice *agresivnost, strah, frustracija/vznemirjenost* ter *socialna plašnost*) in *pozitivno čustvovanje* (sestavljajo ga podlestvice *zadovoljstvo ob močnih dražljajih, zadovoljstvo ob šibkih dražljajih, zaznavna občutljivost* in *povezovanje z drugimi*).

V prvem koraku smo preverili ujemanje enofaktorskega modela za posamezno podlestvico, pri čemer smo iz nadaljnjih analiz (tj. KFA drugega reda) izločili postavke, ki so bile prenizko nasičene s posameznim faktorjem ($\lambda < 0{,}30$) (Kline, 2010). Postavke, ki smo ji izločili iz nadaljnjih analiz, so 38R ($\lambda = 0{,}29$), 43R ($\lambda = 0{,}15$), 10R ($\lambda = 0{,}21$), 58 ($\lambda = 0{,}28$), 60 ($\lambda = 0{,}16$) in postavka 64 ($\lambda = 0{,}25$). Ohranjene postavke (tabela 1) imajo ustrezno visoke faktorske uteži na predpostavljenem faktorju (podlestvici), vrednosti mer RMSEA, CFI, TLI, SRMR in $\chi2$ za posamezne temperamentne podlestvice pa v splošnem kažejo zadovoljivo prileganje podatkov obravnavanim modelom (tabela 2).

Pri faktorskih modelih podlestvic, ki niso dosegli zadovoljivega prileganja, smo pregledali modifikacijske indekse in dopustili korelacijo napak med postavkami, dokler nismo dosegli zadovoljivega prileganja podatkov obravnavanemu modelu (npr. Mueller in Hancock, 2008). Povezanost napak smo dopustili med postavko 34 R (*V šoli težko preklopim od enega učnega predmeta k drugemu.*) in postavko 59 (*Kadar mi kdo razlaga, kako naj nekaj naredim, ga pozorno poslušam.*). Obe postavki eksplicitno ocenjujeta raven ohranjanja pozornosti. Povezanost napak smo dopustili tudi med postavkama 35 (*Skrbi me za mojo družino, kadar nismo skupaj.*) in 51 (*Skrbi me, da bi moji starši umrli ali me zapustili.*). Z njima ocenjujemo izraženost temperamentne poteze strah in se pomensko v precejšnji meri prekrivata, predvsem glede strahu ali negotovosti pred izgubo bližnjega.

Pri podlestvici *inhibitorni nadzor* je bil model natanko identificiran (saturiran), zaradi česar preverjanje prileganja modela ni mogoče. Kot problematična se je pokazala podlestvica zadovoljstvo ob močnih dražljajih ($\chi2$ (9) = 48,465; $p = 0{,}00$; RMSEA = 0,136, 90 % IZ [0,100–0,174]; CFI = 0,75; TLI = 0,59; SRMR = 0,08), pri kateri bi izločitev prenizko nasičenih postavk (tj. štiri od šestih) lahko vodila k neidentificanemu modelu. V zadnjem koraku konfirmatorne faktorske analize smo preverili ujemanje modela na ravni hierarhično nadrednih temperamentnih dimenzij (*prizadevni nadzor, negativno čustvovanje* in *pozitivno čustvovanje*), pri čemer smo skladno z analizami drugih študij (npr. Snyder idr., 2015) dopustili vzajemno povezanost med lestvicami. Tudi na ravni nadrednih dimenzij vrednosti mer RMSEA, CFI, TLI, SRMR in $\chi2$ v splošnem kažejo zadovoljivo prileganje podatkov obravnavanim modelom (tabela 2).

Tabela 1: Faktorske uteži pri konfirmatorni faktorski analizi za postavke EATQ-R-SF.

Podlestvica	**Postavka**	**λ**	***SE* (λ)**	***t***	***p***
Nadzor dejavnosti	7R	0,37	0,10	3,50	< 0,001
	18R	0,37	0,09	4,02	< 0,001
	30	0,58	0,07	7,96	< 0,001
	39	0,48	0,08	5,87	< 0,001
	49R	0,61	0,09	7,13	< 0,001
Pozornost	1	0,55	0,09	6,42	< 0,001
	34R	0,47	0,08	5,85	< 0,001
	41	0,30	0,09	3,41	≤ 0,001
	59	0,61	0,10	6,16	< 0,001
	61R	0,55	0,06	8,47	< 0,001
Inhibitorni nadzor	14	0,36	0,10	3,71	< 0,001
	26R	0,63	0,15	4,05	< 0,001
	63R	0,55	0,16	3,55	< 0,001
Agresivnost	5	0,80	0,04	17,38	< 0,001
	9	0,52	0,06	8,57	< 0,001
	13	0,64	0,05	11,93	< 0,001
	22	0,62	0,05	12,56	< 0,001
	50	0,61	0,07	8,81	< 0,001
Strah	32	0,40	0,08	4,68	< 0,001
	35	0,41	0,09	4,75	< 0,001
	40	0,70	0,08	8,44	< 0,001
	46	0,48	0,08	5,76	< 0,001
	51	0,50	0,09	5,73	< 0,001
	57	0,43	0,07	5,82	< 0,001
Frustracija/vznemirjenost	25	0,58	0,07	8,50	< 0,001
	36	0,58	0,07	8,97	< 0,001
	47	0,47	0,08	6,21	< 0,001
	56	0,56	0,08	7,10	< 0,001
	62	0,45	0,08	5,64	< 0,001
Socialna plašnost	8	0,65	0,05	12,67	< 0,001
	15	0,35	0,07	5,09	< 0,001
	45	0,87	0,05	16,73	< 0,001
	53R	0,66	0,07	9,93	< 0,001
Zadovoljstvo ob šibkih dražljajih	4	0,42	0,07	6,25	< 0,001
	16	0,75	0,05	13,90	< 0,001
	23	0,50	0,06	8,56	< 0,001
	33	0,70	0,05	15,24	< 0,001
	65	0,82	0,04	21,26	< 0,001
Zaznavna občutljivost	6	0,66	0,07	8,99	< 0,001
	12	0,55	0,08	6,76	< 0,001
	21	0,59	0,07	8,33	< 0,001
	24	0,50	0,08	6,37	< 0,001
Povezovanje z drugimi	17	0,43	0,07	5,90	< 0,001
	27	0,62	0,07	8,90	< 0,001
	31	0,56	0,08	7,30	< 0,001
	44	0,52	0,08	6,34	< 0,001
	54	0,37	0,08	4,70	< 0,001

Opomba. λ = standardizirana faktorska utež za ustrezno podlestvico, SE = standardna napaka, t = λ/SE(λ), *p* = vrednost *p* za dvostranski test.

Na osnovi predhodno izločene podlestvice *zadovoljstvo ob močnih dražljajih* smo nadredno dimenzijo *pozitivno čustvovanje* obravnavali kot skupek podlestvic *zadovoljstvo ob šibkih dražljajih, zaznavna občutljivost* in *povezovanje z drugimi*. Prileganje celotnega modela je zadovoljivo, $\chi2$ (1016) = 1473,392; p = 0,00; RMSEA = 0,043, 90 % IZ [0,039–0,048]; CFI = 0,81; TLI = 0,80; SRMR = 0,08, povezanost med tremi nadrednimi dimenzijami je nizka do srednje visoka (korelacija med dimenzijama prizadevni nadzor in negativno čustvovanje znaša –0,60, med dimenzijama prizadevni nadzor in pozitivno čustvovanje 0,35 in med dimenzijama negativno čustvovanje in pozitivno čustvovanje –0,17).

V eni izmed zadnjih študij so raziskovalci (Snyder idr., 2015) pri preučevanju strukture temperamenta uporabili bifaktorski pristop, saj z njim lahko dobro pojasnimo nadredno strukturo temperamentnih ali osebnostnih lastnosti. V pričujoči raziskavi smo prav tako poskusili uporabiti tovrstni pristop, vendar kažejo rezultati slabše prileganje podatkov za nadredne temperamentne dimenzije (*prizadevni nadzor*: $\chi2$ (53) = 111,068; p = 0,00; RMSEA = 0,068, 90 % IZ [0,050–0,086]; CFI = 0,88; TLI = 0,82, SRMR = 0,06; *negativno čustvovanje*: $\chi2$ (150) = 236,423; p = 0,000; RMSEA = 0,049, 90 % IZ [0,037–0,061]; CFI = 0,91; TLI = 0,89, SRMR = 0,08; *pozitivno čustvovanje*: $\chi2$ (63) = 60,110; p = 0,580; RMSEA = 0,000, 90 % IZ [0,000–0,036]; CFI = 1,00; TLI = 1,01, SRMR = 0,04) v primerjavi z rezultati konfirmatorne faktorske analize drugega reda (tabela 2).

Preverili smo tudi zanesljivost temperamentnih podlestvic in nadrednih dimenzij, pri čemer smo uporabili McDonaldov koeficient zanesljivosti omega (ω) in Cronbachov koeficient zanesljivosti alfa (α) (tabela 3). Vrednosti se za celoten vzorec gibljejo med 0,44 in 0,78, pri čemer vse tri nadredne dimenzije EATQ-R-SF dosegajo ustrezno zanesljivost za namene validacijske raziskave (α > 0,70; Nunnally in Bernstein, 1994). Podobno kot rezultati izvirne različice EATQ-R-SF (Ellis, 2002) se večina koeficientov zanesljivosti za temperamentne podlestvice giblje pod 0,70. Ocena zanesljivosti ni zadovoljiva pri podlestvici *inhibitorni nadzor* (ω = 0,49), kar je posledica najnižjega možnega števila postavk, ki še lahko tvorijo podlestvico.

Tabela 2: Indeksi prileganja za specifične temperamentne podlestvice in nadredne temperamentne dimenzije.

	RMSEA [90 %	CFI	TLI	SRMR	χ^2 (*df*)	*p*
Prizadevni nadzor	0,051[0,032;	0,90	0,87	0,06	99,326	<
Nadzor dejavnosti	0,095 [0,044;	0,87	0,75	0,05	15,730 (5)	<
Pozornost	0,000 [0,000;	1,00	1,01	0,02	3,633 (4)	<
Inhibitorni nadzor	–	–	–	–	–	–
Negativno čustvovanje	0,042 [0,029;	0,92	0,91	0,07	233,954	<
Agresivnost	0,078 [0,021;	0,97	0,94	0,03	12,250 (5)	<
Strah	0,070 [0,019;	0,95	0,90	0,03	16,836 (8)	<
Frustracija/vznemirjenost	0,047 [0,000;	0,98	0,96	0,03	7,585 (5)	<
Socialna plašnost	0,000 [0,000;	1,00	1,01	0,02	1,627 (2)	<
Pozitivno čustvovanje	0,024 [0,000;	0,98	0,98	0,05	83,957	<
Zadovoljstvo ob šibkih	0,000 [0,000;	1,00	1,00	0,02	4,891 (5)	<
Zaznavna občutljivost	0,034 [0,000;	0,99	0,98	0,02	2,539 (2)	<
Povezovanje z drugimi	0,000 [0,000;	1,00	1,02	0,02	4,181 (5)	<

Opomba. Vrednosti znotraj oglatih oklepajev pri meri RMSEA predstavljajo meje 90-odstotnega intervala zaupanja [spodnja meja, zgornja meja].

Tabela 3: Mere zanesljivosti za specifične podlestvice in nadredne dimenzije temperamenta.

	ω	α
Prizadevni nadzor	0,76 [3]	0,77 [3]
Nadzor dejavnosti	0,56 [5]	0,60 [5]
Pozornost	0,59 [5]	0,60 [5]
Inhibitorni nadzor	0,49 [3]	0,44 [3]
Negativno čustvovanje	0,71 [4]	0,77 [4]
Agresivnost	0,77 [5]	0,78 [5]
Strah	0,66 [6]	0,67 [6]
Frustracija/vznemirjenost	0,66 [5]	0,66 [5]
Socialna plašnost	0,73 [4]	0,72 [4]
Pozitivno čustvovanje	0,79 [3]	0,80 [3]
Zadovoljstvo ob šibkih dražljajih	0,78 [5]	0,78 [5]
Zaznavna občutljivost	0,66 [4]	0,66 [4]
Povezovanje z drugimi	0,61 [5]	0,61 [5]

Opomba. ω = McDonaldov koeficient omega; α = Cronbachov koeficient alfa (α). Vrednosti v oglatih oklepajih predstavljajo število postavk, ki sestavljajo posamezno podlestvico (z

izločenimi postavkami) oziroma število podlestvic, ki sestavljajo posamezno temperamentno dimenzijo.

Mere opisne statistike in analiza razlik med spoloma v izraznosti temperamentnih značilnosti

V tabeli 4 predstavljamo mere opisne statistike za celoten vzorec in glede na spol ter analizo razlik med spoloma v ravni izraznosti specifičnih temperamentnih potez in nadrednih dimenzij. Statistično značilne razlike med spoloma so se pojavile v ravni izraznosti *strahu* (d = 0,62), *zadovoljstva ob šibkih dražljajih* (d = 0,40) in *povezovanja z drugimi* (d = 0,44), kjer dosegajo mladostnice višje povprečne vrednosti v primerjavi z mladostniki. Prav tako smo ugotovili statistično značilno višjo izraznost nadredne dimenzije *pozitivno čustvovanje* (d = 0,43) pri mladostnicah v primerjavi z mladostniki. Učinek spola je pri vseh podlestvicah in dimenzijah majhen do srednje velik.

Tabela 4: Mere opisne statistike za specifične podlestvice in nadredne dimenzije temperamenta ter analiza razlik med spoloma.

	M (SD)	*M (SD)*	*M (SD)*	*t*	*p*
Prizadevni nadzor	3,30 (0,59)	3,32 (0,57)	3,29 (0,60)	0,36	0,719
Nadzor dejavnosti	2,94 (0,76)	2,92 (0,72)	2,95 (0,80)	–0,30	0,762
Pozornost	3,65 (0,65)	3,69 (0,64)	3,62 (0,65)	0,94	0,348
Inhibitorni nadzor	3,32 (0,76)	3,34 (0,78)	3,31 (0,75)	–	–
Negativno čustvovanje	2,92 (0,50)	2,86 (0,54)	2,98 (0,46)	–1,82	0,070
Agresivnost	2,39 (0,87)	2,49 (0,90)	2,30 (0,83)	1,71	0,090
Strah	3,17 (0,83)	2,90 (0,85)	3,40 (0,75)	**–4,82**	**0,000**
Frustracija/vznemirjenost	3,55 (0,79)	3,53 (0,80)	3,56 (0,77)	–0,34	0,731
Socialna plašnost	2,57 (0,96)	2,50 (0,99)	2,64 (0,94)	–1,06	0,290
Pozitivno čustvovanje	3,63 (0,62)	3,49 (0,65)	3,75 (0,56)	**–3,39**	**0,001**
Zadovoljstvo ob šibkih	3,37 (0,96)	3,17 (0,94)	3,54 (0,94)	**–3,02**	**0,003**
Zaznavna občutljivost	3,62 (0,80)	3,54 (0,88)	3,68 (0,72)	–1,40	0,162
Povezovanje z drugimi	3,91 (0,65)	3,76 (0,70)	4,04 (0,57)	**–3,34**	**0,001**

Opomba. N = 238, 110 mladostnikov (46,2 %) in 128 mladostnic (53,8 %). Razliko med spoloma pri posameznih podlestvicah in nadrednih dimenzijah EATQ-R-SF smo izračunali na ravni $p < 0,05$.

Razprava

V pričujoči raziskavi smo želeli preučiti strukturo in notranjo zanesljivost prevedene ter prilagojene kratke različice Vprašalnika temperamenta za zgodnje mladostnike (EATQ-R-SF, Ellis in Rothbart, 2001), namenjene ocenjevanju temperamenta v zgodnjem mladostništvu.

Z njim preko samoocene mladostnikov ugotavljamo raven izraznosti značilnosti, kot so živahnost, pozornost, različne vrste čustvovanja, zaznavna občutljivost in sestavine samouravnavanja. Dodatno smo želeli preučiti razlike med spoloma v ravni izraznosti specifičnih temperamentnih potez in hierarhično nadrednih temperamentnih dimenzij. Čeprav naše ugotovitve nakazujejo možnost uporabe EATQ-R-SF pri slovenskih zgodnjih mladostnikih v raziskovalne namene, se na osnovi rezultatov pričujoče študije in preteklih študij v tujini (npr. Muris in Meesters, 2009; Viñas idr., 2015; Visser idr., 2007; Zhang idr., 2008) kaže potreba po celostnem izboljšanju merskega pripomočka in načinov statistične obdelave podatkov ter morebitna ponovna opredelitev specifičnih in nadrednih temperamentnih značilnosti.

S pomočjo konfirmatorne faktorske analize drugega reda pri slovenskih mladostnikih nismo pokazali zadovoljivega prileganja podatkov izvirnemu modelu temperamenta iz ZDA, ki v zgodnjem mladostništvu vključuje 12 temperamentnih potez, povezanih v štiri hierarhično nadredne dimenzije: *živahnost, negativno čustvovanje, prizadevni nadzor* in *povezanost* (Ellis in Rothbart, 2001). Zadovoljivega prileganja tako opredeljenemu modelu niso podprli niti rezultati predhodnih tujih raziskav, ki pretežno nakazujejo ustreznejše prileganje trifaktorskemu modelu temperamenta z nadrednimi dimenzijami *živahnost* (ali *pozitivno čustvovanje*), *negativno čustvovanje* in *prizadevni nadzor* (npr. Muris in Meesters, 2009; Visser idr., 2007) ali dimenzijami *živahnost* (ali *pozitivno čustvovanje*), *prizadevni nadzor* in *povezanost* (npr. Viñas idr., 2015). Na osnovi teh spoznanj smo se odločili uporabiti trifaktorski model temperamenta, ki ga je avtorica izvirnega vprašalnika predlagala po objavi njegove revidirane oblike in so ga preverili Snyder ter sodelavci (2015). Struktura temperamenta zgodnjih mladostnikov naj bi tako vključevala 10 specifičnih temperamentnih potez, ki se združujejo v tri hierarhično nadredne dimenzije: *prizadevni nadzor* (vključuje *pozornost, nadzor dejavnosti* in *inhibitorni nadzor*), *negativno čustvovanje* (s potezami *agresivnost*, *strah, frustracija/vznemirjenost* ter *socialna plašnost*) in *pozitivno čustvovanje* (z označevalnimi potezami *zadovoljstvo ob šibkih dražljajih*, *zaznavna občutljivost* in *povezovanje z drugimi*). KFA na ravni podlestvic je v splošnem pokazala zadovoljivo prileganje modela,

čeprav indeksi prileganja za nekatere podlestvice (npr. *nadzor dejavnosti*) niso dosegli priporočenih vrednosti. Iz končnega modela smo izločili podlestvico *zadovoljstvo ob močnih dražljajih*, saj bi opustitev prevelikega števila nizko nasičenih postavk vodila k neidentificiranemu modelu. O nizki nasičenosti postavk podlestvice *zadovoljstvo ob močnih dražljajih* (npr. »*Ne bi se želel udeležiti divjih voženj v doživljajskem parku (vlakec smrti, prosti pad).*«) poročajo tudi Snyder in sodelavci (2015), ki prav tako niso podprli predvidene strukture pozitivnega čustvovanja (kot jo je predlagala avtorica izvirnega vprašalnika). Snyder in sodelavci (2015) tako predlagajo obravnavo lestvice *zadovoljstvo ob močnih dražljajih* kot neodvisnega faktorja, čeprav je s tem vprašljiva veljavnost latentne dimenzije pozitivno čustvovanje, ki jo raziskovalci najpogosteje opredeljujejo kot doživljanje ugodja in pozitivnega vznemirjenja ter iskanje dražljajev.

O nezadovoljivem prileganju podatkov izvirnemu modelu, manjšem številu prepoznanih temperamentnih potez in nadrednih dimenzij (ne glede na rabo dolge ali kratke različice samoocenjevalne oblike EATQ-R) ter vsebinskem prekrivanju postavk, ki maje jasno strukturo vprašalnika, poročajo tudi drugi raziskovalci. Hsu (2011) je pri tajvanskih zgodnjih mladostnikih prepoznal štirifaktorsko strukturo temperamenta, medtem ko je Chang (2005) pri kitajskih zgodnjih mladostnikih prepoznal sedem temperamentnih potez s tremi nadrednimi dimenzijami. Visser in sodelavci (2007) so pri nizozemskih zgodnjih mladostnikih prepoznali sedem temperamentnih dimenzij, medtem ko sta Muris in Meesters (2009) pri belgijskih zgodnjih mladostnikih prepoznala devet temperamentnih potez, ki se združujejo v tri nadredne temperamentne dimenzije (brez dimenzije *povezanost*). Podobno ugotavlja tudi Viñas Poch s sodelavci (2015) pri španskih zgodnjih mladostnikih, kjer je bilo najbolj zadovoljivo prileganje modela z osmimi temperamentnimi potezami in tremi nadrednimi dimenzijami.

Z nekoliko drugačnim pristopom je strukturo temperamenta zgodnjih mladostnikov preučila Snyder s sodelavci (2015). Predpostavili so, da posamezno temperamentno dimenzijo nasičujeta tako splošen (skupni) faktor kot specifični faktorji. Splošen faktor nasičuje vse, ne nasičuje pa dovolj močno prvotnih faktorjev, ki po drugi strani neodvisno obvladujejo posamezne spremenljivke. Slednje smo preverili tudi v pričujoči raziskavi, vendar je bilo prileganje podatkov trem nadrednim dimenzijam slabše v primerjavi z rezultati konfirmatorne faktorske analize drugega reda, ki odraža nekoliko prilagojeno združevanje podlestvic v nadredne dimenzije (Ellis, 2007, v Snyder idr., 2015) kot izvorna različica EATQ-R-SF (Ellis, 2002).

Čeprav raziskav z bifaktorskim pristopom k preučevanju temperamenta zgodnjih mladostnikov nismo zasledili, s tovrstnim pristopom raziskovalci dobro pojasnjujejo nadredno strukturo osebnostnih lastnosti pri odraslih (npr. Chen, Hayes, Carver, Laurenceau in Zhang, 2012; Musek, 2011) in psihopatoloških dimenzij pri mladostnikih ter odraslih (npr. Caspi idr., 2014; Tackett idr., 2013). Tovrstni pristop omogoča pregled povezanosti ter odnosa z drugimi preučevanimi spremenljivkami in odpravi napako variance (Snyder idr., 2015).

Zanesljivost nadrednih dimenzij EATQ-R-SF je zadovoljiva za namene preliminarne ali validacijske raziskave, vendar se ocene zanesljivosti podlestvic *inhibitorni nadzor, pozornost* in *nadzor dejavnosti* gibljejo pod sprejemljivo vrednostjo 0,60 (De Vellis, 1991). Rezultati analize zanesljivosti v pričujoči študiji so primerljivi z rezultati izvirne EATQ-R-SF (Ellis, 2002) in predhodnih validacijskih študij. O nizki zanesljivosti podlestvic *inhibitorni nadzor* in *pozornost* pri turških zgodnjih mladostnikih poročajo Demirpence in Putnam (2019) ter Viñas Poch s sodelavci (2015), ki pri španskih zgodnjih mladostnikih ugotavljajo nesprejemljivo nizko zanesljivost podlestvice *pozornost*. Do določene mere lahko nizek koeficient zanesljivosti nekaterih podlestvic pričakujemo pri katerem koli vzorcu zgodnjih mladostnikov, saj se notranja skladnost lestvic negativno povezuje s številom postavk, ki jih tvorijo (Gliem in Gliem, 2003). Nižje zanesljivosti podlestvic *inhibitorni nadzor, pozornost* in *nadzor dejavnosti* pri slovenskih zgodnjih mladostnikih tako pripisujemo majhnemu številu postavk v pripadajočih podlestvicah. Lahko pa k nizki zanesljivosti prispevajo obratno vrednotene postavke z dvojnim zanikanjem, ki so v slovenskem jeziku težko razumljive zgodnjim mladostnikom (npr. *Tudi ko se trudim, da ne bi delal tistega, česar ne smem, mi to ne uspe*.), čeprav ima večina povprečno visoke faktorske uteži na predpostavljenem faktorju. Zaradi vprašljive notranje skladnosti omenjenih lestvic je pri preučevanju temperamentnih potez slovenskih zgodnjih mladostnikov smiselno uporabiti podlestvice dolge različice EATQ-R, ki vključujejo večje število postavk. Kljub nezadovoljivi notranji skladnosti nekaterih temperamentnih podlestvic, je vprašalnik EATQ-R-SF zanesljiv za uporabo rezultatov v raziskovalne namene pri slovenskih zgodnjih mladostnikih. Smiselno pa je uporabiti le posamezne podlestvice, ki nakazujejo izraznost posameznih temperamentnih potez in napovedujejo različne psihosocialne izide (npr. socialna kompetentnost, težave ponotranjenja, učna uspešnost) (Al-Hendawi, 2012; Demirpence in Putnam, 2019; Valiente idr., 2013). Nekateri avtorji (npr. Demirpence in Putnam, 2019) priporočajo, da raziskovalci, katerih vprašanja niso izključno vezana na specifične temperamentne poteze, uporabijo zgolj dosežke na ravni dimenzij.

Slovenske zgodnje mladostnice so se ocenjevale nekoliko višje glede *strahu*, *zadovoljstva ob šibkih dražljajih* in *povezovanja z drugimi* kot mladostniki, to pa se v določeni meri ujema z ugotovitvami tujih raziskav (npr. Ellis in Rothbart, 2001; Else-Quest idr., 2006; Sooyeon, Brody in Murry, 2003; Muris in Meesters, 2009; Veenstra idr., 2008) in nakazuje kriterijsko veljavnost vprašalnika. Višje povprečne vrednosti zgodnjih mladostnic pri lestvici *strah* so lahko odraz stereotipnega odzivanja drugih na njihovo čustvovanje, saj jih v primerjavi s fanti zaznavajo kot tiste, ki doživljajo ter izražajo več stiske, zadrege, strahu, krivde in žalosti (Brody in Hall, 2000; Plant, Hyde, Keltner in Devine, 2000). Dekleta tudi učinkoviteje zaznavajo šibke dražljaje in se močneje zavedajo subtilnih sprememb v okolju kot fantje (Else-Quest idr., 2006), ključno vlogo pa imajo tudi odzivi odraslih/vrstnikov na vedenje dečkov/fantov, ki so tesno pogojeni z nadzorom in omejevanjem pretiranega izražanja čustev zavrtosti, kot je na primer jok (Brody, 2000). Na ravni nadrednih temperamentnih dimenzij so se slovenske mladostnice ocenile višje pri *pozitivnem čustvovanju* kot mladostniki, kar se ne ujema z ugotovitvami tujih raziskav, v katerih sta se *zadovoljstvo ob močnih dražljajih* in *živahnost* pokazali kot višje izraženi pri fantih (npr. Viñas idr., 2015; Zhang idr., 2008). Takšno neujemanje je lahko posledica izločitve podlestvice zadovoljstvo ob močnih dražljajih pri slovenskem vzorcu. Nenazadnje je treba poudariti, da ugotovitve o razlikah med spoloma niso neposredno primerljive z razlikami v tujih raziskavah, saj smo v pričujoči raziskavi ugotovili drugačno strukturo temperamenta v zgodnjem mladostništvu.

Zaključek

Vprašalnik EATQ-R-SF se je od časa njegovega nastanka ob majhnih strukturnih spremembah izkazal kot uporaben in zanesljiv merski pripomoček v različnih kulturnih okoljih (npr. Hoffmann, Pérez, Garcia, Rojas in Martinez, 2017), vendar je odsotnost enotne faktorske strukture vodila do nedoslednosti v opredelitvi števila specifičnih temperamentnih potez in hierarhično nadrednih dimenzij. Ugotovitve o različnih načinih združevanja specifičnih temperamentnih potez v nadredne dimenzije ovirajo napredek pri razumevanju strukture temperamenta zgodnjih mladostnikov, predvsem pa njegove povezanosti s psihosocialnimi izidi (Snyder idr., 2015).

Na podlagi rezultatov pričujoče študije je smiselno preveriti psihometrične značilnosti dolge različice EATQ-R, pri čemer je ob priredbi merskega pripomočka treba razmisliti o izločitvi ali preoblikovanju obratno vrednotenih postavk z dvojnim zanikanjem, ki so lahko težko razumljive zgodnjim mladostnikom (Muris in Meesters, 2009) in postavk pri podlestvici *zadovoljstvo ob močnih dražljajih* ter *inhibitorni nadzor*, saj sta se izkazali kot najmanj zanesljivi. Ustrezna prilagoditev merskega pripomočka za ocenjevanje potez in nadrednih dimenzij temperamenta zgodnjih mladostnikov je ključnega pomena, predvsem na osnovi spoznanj o vlogi temperamenta v različnih psihosocialnih izidih, kot sta socialno vedenje (socialna kompetentnost, vedenje ponotranjenja in vedenje pozunanjenja; npr. Muris idr., 2007; Wang idr., 2016) in učna uspešnost (Checa, Rodríguez-Bailón in Rueda, 2008).

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Summary

We have noticed rapid advances in the field of temperament development in recent decades, which also extended research and the construction of measurement instruments from childhood into adolescence. The study of temperament, early emerging individual differences in reactivity and regulation, which remain relatively stable and persist throughout life, is important, since temperamental traits play an important role in adjustment and other developmental outcomes. However, the use of temperament measurements in Slovenia seems very limited and focused only on children. Thus, we translated and adapted (two independent translations by experts and reverse translation) the Revised Early Adolescent Temperament Questionnaire – Short Form (EATQ-R-SF; Ellis & Rothbart, 2001). The present study aimed to examine its psychometric characteristics and gender differences in mean levels of trait scores on a sample of Slovenian early adolescents. In order to validate the questionnaires, we conducted analyses of data obtained from 238 participants (128 girls, 110 boys), aged from 11.50 to 14.60 years (M = 12.40 years, SD = 8 months).

They completed a 65-item self-report version of the EATQ-R-SF, assessed along a 5-point Likert scale (1 - almost never true; 5 - almost always true). Since its release, the research has combined the EATQ-R-SF subscales in different ways. We decided to explore the currently recommended model that subsumes the temperament subscales into three higher-order dimensions: (1) *Effortful control* (EC) includes the subscales of *attention*, *activation control*, and *inhibitory control*; (2) *Negative emotionality* (NA) comprises the subscales of *aggression*, *fear*, *frustration* and *shyness* (*depressed mood* is not included), and (3) *Positive emotionality* (PE) consists of the *high intensity pleasure/surgency*, *pleasure sensitivity*, *perceptual sensitivity* and *affiliation* subscales (Ellis, 2007; Snyder et al., 2015). The students filled in the questionnaire during their class time. We conducted confirmatory factor analyses (CFA) separately for each subscale in the first step, and removed the items with low loadings (i.e., items 38R, 43R, 10R, 58, 60, and 64). We examined the modification indices and added correlated residual variance for item-pairs 34R/59 and 35/51 sequentially to improve the model fit. The results showed a satisfactory fit of the models, although the fit indices for some subscales (e.g., activation control) did not reach the recommended values. The second-order CFA (combining subscales into three higher-order dimensions – EC, NE, and PE) showed that the fit results for this model were also satisfactory. We discarded the *high-intensity pleasure/surgency* subscale from the final model (PE dimension) because dropping too many items with low factor loadings would lead to an unidentified model. We also tested bi-factorial models for each dimension, but the results suggested a poorer fit compared to the hierarchical model. The higher-order scales of EATQ-R-SF had an acceptable reliability, although the coefficients for the subscales *inhibitory control, attention*, and *activation control* were below the acceptable values. We further analyzed mean level differences in adolescents' temperament traits and dimensions. Girls scored higher on *fear*, *pleasure sensitivity*, and *affiliation* than boys. In contrast to previous research reports, the girls also outperformed the boys with respect to *positive emotionality*, and we found no gender differences in *aggression, shyness*, and *frustration*. The results suggest that the EATQ-R-SF is applicable to Slovenian early adolescents and appropriate for research purposes, although it needs further improvement. Due to lower reliability of few temperament subscales, the respective scores require cautious interpretation.

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REVIJA ZA ELEMENTARNO IZOBRAŽEVANJE
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»Jaz sem 16 % madžar in 50 % slovenec in 80 % angležž.« Jezikovni portreti petošolcev na narodnostno mešanih območjih

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Abstract/Izvleček V pričujočem članku smo v sklopu projekta »Jeziki štejejo« s pomočjo t. i. instrumenta *jezikovni portreti* ugotavljali razlike v dojemanju posameznih jezikov med učenci petih razredov. Posebno pozornost smo namenili primerjavi odgovorov med učenci, ki obiskujejo osnovne šole na narodno mešanem območju slovenske Istre in Prekmurja, in učenci, ki obiskujejo osnovne šole drugje v Sloveniji. Na podlagi rezultatov smo ugotovili, da med učenci prihaja do statistično značilnih razlik glede na obiskovan model osnovne šole v tem, katere jezike so najpogosteje označevali v jezikovnih portretih in katero mesto so posameznim jezikom dodelili.

***"I am 16% Hungarian and 50% Slovene and 80% English."* Language Portraits of Fifth-grade Elementary School Students from Nationally Mixed Areas** In this article, which originated as part of the project "Jeziki štejejo" (Languages matter), we discuss the differences in perception of individual languages, expressed through language portraits created by fifth-grade elementary school students. Special attention was paid to the comparison of portraits between pupils in nationally diverse regions (Slovenian Istria and Prekmurje) and pupils in other parts of the country. The results of quantitative analysis of these language portraits reveal statistically relevant differences with regard to the school model. Differences were particularly evident in the choice of marked languages and the position of each individual language in the language portraits.

Ključne besede:
language portraits, multilingualism, minority languages, elementary school, nationally mixed areas

Keywords:
jezikovni portreti, večjezičnost, manjšinski jeziki, osnovnošolci, narodno mešana območja

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Uvod

Članek obravnava razlike v dojemanju posameznih jezikov, izražene skozi t. i. jezikovne portrete učencev z narodno mešanih območij in drugje v Sloveniji. V teoretičnem delu predstavljamo izhodišča za uporabo znanstvenega instrumenta, v empiričnem delu pa predstavljamo kvantitativno in kvalitativno analizo jezikovnih portretov, izdelanih v petih razredih osnovnih šol iz projekta »Jeziki štejejo«.
Osnovo teoretičnih izhodišč predstavlja 11. člen Ustave Republike Slovenije (2016), ki določa, da v Sloveniji slovenščina velja kot uradni jezik. Na območjih občin, v katerih živita italijanska in madžarska narodna skupnost, pa kot uradni jezik velja tudi italijanščina ali madžarščina. Za vzgojno-izobraževalni prostor oz. proces to pomeni, da se na narodno mešanih območjih slovenščina in italijanščina oz. slovenščina in madžarščina pojavljata v različnih vlogah: (1) kot učni jezik (oz. kot jezik, v katerem poteka učni proces) in/ali (2) kot učni predmet. Ker se glede na narodno mešano območje model vključevanja manjšinskega jezika v učni proces razlikuje, bomo v nadaljevanju predstavili, kako vzgojno-izobraževalne institucije na narodno mešanem območju slovenske Istre v učni proces vključujejo italijanščino in kako vzgojno-izobraževalne institucije na narodno mešanem območju Prekmurja v učni proces vključujejo madžarščino.

Slovenščina vs. italijanščina

Na območju, kjer živi italijanska narodna skupnost – obalne občine (Ankaran, Izola, Koper in Piran) ter nekaj okoliških krajev in vasi, ki se nahajajo znotraj slovenske Istre in predstavljajo etnično mešano ozemlje – poteka učni proces ali v italijanščini ali v slovenščini. Obstajata torej dve varianti (Straus, 2018, str. 13–14; Novak Lukanovič 1998):

- *varianta 1:* če učni proces poteka v italijanščini, je slovenščina obvezen učni predmet;
- *varianta 2:* če učni proces poteka v slovenščini, je italijanščina obvezen učni predmet.

Ne glede na to, v katerem jeziku poteka učni proces (bodisi v slovenščini ali v italijanščini) in kateri jezik je učni predmet (bodisi slovenščina ali italijanščina), bi lahko domnevali, da je v enem šolskem letu tako učnemu jeziku (v preglednici 1 okrajšano kot UJ) kot učnemu predmetu (v preglednici 1 okrajšano kot UP) namenjeno enako število ur. Kot prikazuje preglednica 1, pa v številu ur prihaja do razlik.

Tabela 1: Število ur, namenjenih UJ (slovenščina/italijanščina) in UP (slovenščina/italijanščina) v enem šolskem letu po razredih (Ministrstvo za izobraževanje, znanost in šport, 2011).

	Število ur v šolskem letu glede na razred								
Varianta 1:	1.	2.	3.	4.	5.	6.	7.	8.	9.
italijanščina kot UJ	210	245	245	175	175	175	140	122,5	144
slovenščina kot UP	105	140	122,5	122,5	105	105	105	105	96
Varianta 2:	1.	2.	3.	4.	5.	6.	7.	8.	9.
slovenščina kot UJ	210	245	245	175	175	175	140	122,5	144
italijanščina kot UP	70	70	70	70	70	70	70	70	64

V učnem načrtu je predvideno enako število ur za učni jezik, neodvisno od tega, ali učni proces poteka v slovenščini ali v italijanščini. Kot je razvidno iz preglednice 1, pa med slovenščino in italijanščino prihaja do razlik v številu ur, če je jezik učni predmet. Če je italijanščina učni predmet, je temu jeziku namreč namenjeno manjše število ur.

Slovenščina vs. madžarščina

Na narodno mešanem območju v Prekmurju, kjer živi madžarska narodna skupnost, je z zakonom določeno dvojezično šolstvo (Straus, 2018, str. 14). V Prekmurju delujejo štiri dvojezične osnovne šole: DOŠ I Lendava, DOŠ Genterovci, DOŠ Dobrovnik in DOŠ Prosenjakovci. Dvojezični model se nadaljuje na Dvojezični srednji šoli Lendava. Kot opredeljujeta Rudaš in Kolláth (2017, str. 78–79), se v okviru dvojezičnega šolskega izobraževanja učenci tako slovenske (ali druge) kot madžarske narodnosti srečujejo z obema jezikoma – slovenskim in madžarskim. Tudi v dvojezičnem modelu posledično razlikujemo med 2 variantama:

- *varianta 1:* madžarščina je prvi jezik učencev madžarske narodnosti in drugi jezik učencev slovenske (ali druge) narodnosti;
- *varianta 2:* slovenščina je prvi jezik učencev slovenske (ali druge) narodnosti in drugi jezik madžarske narodnosti.

V primerjavi z vzgojno-izobraževalnim procesom na narodno mešanem območju slovenske Istre imata v dvojezičnem modelu oba jezika – tako madžarščina kot slovenščina – vlogo učnega jezika in učnega predmeta. To pomeni, da se učenci celotno učno snov ali del učne snovi učijo v obeh jezikih (prav tam, str. 68).
Kljub temu da učni proces poteka v obeh jezikih in da sta oba jezika obenem tudi učna predmeta, pa tudi tukaj prihaja do razlik glede na število ur, ki so namenjene prvemu (v preglednici 2 okrajšano kot J1) in drugemu jeziku (v preglednici okrajšano kot J2) v enem šolskem letu.

Tabela 2: Število ur, namenjenih J1 (slovenščina/madžarščina) in J2 (slovenščina/madžarščina) v enem šolskem letu po razredih (Ministrstvo za izobraževanje, znanost in šport, 2011).

	Število ur v šolskem letu glede na razred								
Varianta 1:	1.	2.	3.	4.	5.	6.	7.	8.	9.
madžarščina kot J1	210	210	210	175	175	175	140	122,5	144
slovenščina kot J2	105	140	140	175	175	175	140	122,5	144
Varianta 2:	1.	2.	3.	4.	5.	6.	7.	8.	9.
slovenščina kot J1	210	210	210	175	175	175	140	122,5	144
madžarščina kot J2	105	140	122,5	122,5	105	105	105	105	96

Iz preglednice 2 je razvidno, da do razlik prihaja zgolj pri drugem jeziku. Učencem madžarske narodne skupnosti, katerih drugi jezik je slovenščina, je namreč namenjeno večje število ur. Učencem slovenske narodne skupnosti, katerih drugi jezik je madžarščina, pa je v učnem načrtu namenjeno manjše število ur za drugi jezik.
Takšna situacija glede ur posameznih jezikov – slovenščina, italijanščina, madžarščina – predstavlja osnovo za primerjavo med šolami na narodno mešanem območju z drugimi šolami, ki jih je projekt zajel. Zanimalo nas bo torej, v kolikšni meri se opisana situacija odslikava na jezikovnih portretih petošolcev.

Cilj članka

Poglavitni cilj članka je proučiti, v kolikšni meri prihaja do razlik med učenci, ki obiskujejo osnovne šole na narodno mešanem območju (slovenska Istra in Prekmurje), in učenci, ki obiskujejo osnovne šole, vključene v projekt, drugje v Sloveniji, in sicer glede na to, koliko in katere jezike vključujejo v svoj jezikovni repertoar, v kakšen odnos jih postavljajo med seboj in kako svoj izbor pojasnjujejo.

Empirična raziskava

V empirični raziskavi smo kvantitativno in deloma tudi kvalitativno analizirali jezikovne portrete (raziskovalni instrument), ki so jih izdelali učenci petih razredov osnovnih šol na narodno mešanem območju in drugje v Sloveniji (raziskovalni vzorec).

Raziskovalni instrument

Jezikovni portreti predstavljajo raziskovalno orodje posebne vrste. Gre za list papirja, na katerem je skicirana silhueta človeškega telesa, desno od nje pa so prazni okvirčki za legendo. Z izdelovanjem jezikovnega portreta učenci govorijo o jezikih tako, da določene dele telesa povežejo z jeziki, pri čemer lahko svoje odločitve tudi pojasnijo. Navodila za izdelavo jezikovnega portreta nakazujejo zapletenost uporabe, saj določajo dve pravili (izdelaj svoj jezikovni portret tako, da dele telesa različno obarvaš, pri tem vsaka barva predstavlja en jezik, kar zapišeš ob legendi), obenem pa odpirajo odprt prostor (svoj izbor lahko pojasniš). Odprtost koncepta predstavljajo simbolni pomeni določenih delov telesa kot tudi zaporedje navedenih jezikov v legendi.

Ideja jezikovnih portretov je bila razvita, da bi v jezikovno raznolikih šolskih razredih, kjer učenci govorijo različne prve jezike, spodbujali jezikovno zavedanje (Neumann, 1991; Krumm/Jenkins, 2001). Pri zasnovi omenjenega raziskovalnega orodja izhajamo iz tega, da se usvajanje jezikov in jezikovna raba odvijata vedno v konkretnih socialnih in zgodovinsko-biografskih situacijah. To pomeni, da gre za menjavanje individualnih, pogosto čustveno določenih ravnanj in družbenih struktur, ki taka jezikovna ravnanja podpirajo ali pa otežujejo (Krumm, 2011).

Ta razmerja so še posebej zapletena pri tistih skupinah, ki se soočajo z dnevnim menjavanjem jezikovnega koda, npr. pri migrantih ali manjšinah. Zlasti pri slednjih lahko s pomočjo jezikovnih portretov ugotovimo, s katerimi situacijami posamezniki povezujejo posamezne jezike – kateri jezik uporabljajo z družinskimi člani, kateri jezik uporabljajo v vsakodnevnem okolju, kateri jezik uporabljajo v učnem oz. delovnem okolju itd. (Krumm, 2010). Ta pristop se naslanja na jezikovni model (Franceschini, 2001), s pomočjo katerega se ugotavlja večjezičnost v razmerju centra in periferije. V centru posameznikova jezikovnega sistema se nahajajo tisti jeziki oz. tiste jezikovne zvrsti, s katerimi se posameznik v določeni situaciji najprej identificira (Franceschini, 2001, str. 114). To pomeni, prvi in drugi jezik posameznika (npr. slovenščina in madžarščina) veljata kot njegova centralna jezika; oba jezika sta tudi del njegovega šolskega vsakdana. Njegovi t. i. jeziki periferije so torej vsi drugi jeziki, s katerimi posameznik prihaja v stik (npr. angleščina, nemščina idr.); ti imajo za posameznika spreminjajočo se vlogo – v osebnem prostoru posameznika sicer nimajo osrednje vloge, imajo pa jo v učnem prostoru (gl. Franceschini, 2001; Krumm, 2010).

Jezikovni portreti ponujajo odgovor znanosti na vprašanja o teh razmerjih in predstavljajo dostop ali pa pot do jezikovnih biografij, kar je še posebej primerno za otroke, saj lahko spontano izrazijo odnos do jezikov v svojem življenju. Jezikovni portreti so bili uporabljeni v različnih okoljih – projekti, izobraževanja, delavnice v nemško govorečih državah – Skandinaviji, Kanadi, Avstraliji (gl. Busch, 2011), in to pogosto na šolah, kjer je delež otrok iz družin migrantov sorazmerno velik. Ob tem so bili uporabljeni tudi na dvojezičnem območju, konkretno leta 2007 na Koroškem v Avstriji (gl. Busch, 2011). Analizirani so bili večinoma tako, da so se glede na gradivo določevali tipi jezikovnih portretov (Krumm, 2003, 2011), pogosto so bili interpretirani komentarji, ki so jih učenci zapisovali. Predstavljajo pa lahko tudi osnovo za razvijanje didaktičnega gradiva za pouk (Galling, 2011). Sklenemo lahko, da so se jezikovni portreti kot raziskovalni instrument uveljavili kot samostojen pristop v raziskovanju jezikovnih biografij.

Raziskovalni vzorec

V sklopu raziskovalnega projekta »Jeziki štejejo« smo pridobili podatke za empirično analizo (šolsko leto 2018/2019). V projektu je sodelovalo 542 učencev petih razredov: 177 učencev (32,7 %), ki so sodelovali v projektu, obiskujejo osnovne šole na narodno mešanem območju, 365 učencev (67,3 %) pa obiskujejo osnovne šole drugje v Sloveniji. V projektu so sodelovale 4 osnovne šole na narodno mešanem območju in 8 osnovnih šol drugje v Sloveniji.

OŠ na narodno mešanem območju:	OŠ drugje v Sloveniji:
Dvojezična osnovna šola Dobrovnik / Dobronakai Ketnyelvu Altalanos Iskola, Osnovna šola Koper, Scuola elementare Osnovna šola Dante Alighieri Isola-Izola, Dvojezična osnovna šola I Lendava / 1. Sz. Lendvai Kétnyelvű Általános Iskola.	Osnovna šola Franca Rozmana Staneta Maribor, Osnovna šola Draga Bajca Vipava, Osnovna šola Janka Padežnika Maribor, Osnovna šola Fokovci, Osnovna šola Milana Šuštaršiča Ljubljana, Osnovna šola ob Dravinji Slovenske Konjice, Osnovna šola Ivana Cankarja Trbovlje, Osnovna šola Ivana Groharja Škofja Loka.

Postopek obdelave podatkov

Koliko in katere jezike so učenci v jezikovnih portretih označevali in kateremu delu telesa so te dodelili, smo v empirični raziskavi analizirali kvantitativno. Na podlagi tega, ali učenci obiskujejo šolo na narodno mešanem območju ali šolo drugje v Sloveniji, smo ugotavljali morebitne razlike med pridobljenimi podatki. Za potrebe kvantitativne empirične analize smo pridobljene podatke statistično obdelali s pomočjo statističnega programskega paketa SPSS (Statistical package for the social sciences). Statistično značilnost razlik smo preverjali na ravni tveganja $p \leq 0{,}05$. Na nivoju deskriptivne in inferenčne statistike smo uporabili naslednje statistične metode:

- absolutne (f) in odstotne (f %) frekvenčne distribucije zajetih karakteristik neštevilskih spremenljivk;
- aritmetične sredine ($\bar{x}$) numerično izraženih spremenljivk in razporeditev le-teh v ranžirno vrsto;
- χ^2-preizkus za preverjanje razlik glede na model osnovne šole v zajetih nominalnih spremenljivkah;
- Mann-Whitneyjev preizkus za preverjanje razlik glede na model osnovne šole v zajetih ordinalnih spremenljivkah.

Če so učenci, ki obiskujejo osnovne šole na narodno mešanih območjih, dodali dodatna pojasnila oz. obrazložitve, zakaj so navedli slovenski, madžarski in/ali italijanski jezik in h kateremu delu telesa so tega dodelili, smo ta pojasnila oz. obrazložitve analizirali kvalitativno. Za potrebe kvalitativne empirične analize smo pridobljene podatke vsebinsko kodirali. Pri tem je bilo opredeljenih 12 različnih kod. Odločitev za jezik v obrisu telesa je bila obrazložena v skupno 36 komentarjih. Največ komentarjev je bilo navedenih za slovenščino (18), sledita italijanščina (12) in madžarščina (5), 1 komentar pa se nanaša na romščino. Ker učenec, ki je navedel romščino, obiskuje dvojezično šolo, je bil ta komentar prav tako vključen v empirično raziskavo.

Rezultati z interpretacijo

Najprej smo želeli ugotoviti, koliko jezikov bodo učenci pri izdelavi jezikovnih portretov navedli.

Tabela 3: Število (f) in strukturni odstotki (f %) učencev po številu jezikov.

Število jezikov	**f**	**f %**
0	2	0,4
1	1	0,2
2	24	4,4
3	62	11,4
4	124	22,9
5	119	22,0
6	74	13,7
7	108	19,9
8 ≥	28	5,3
SKUPAJ	**542**	**100,0**

Kot prikazuje preglednica 3, so učenci pri izdelavi jezikovnih portretov največkrat navedli 4 (skoraj 23 %) ali 5 (22 %) jezikov. Skoraj 20 % učencev je navedlo 7 jezikov. Sledijo učenci, ki so navedli 6 (skoraj 14 %) ali 3 jezike (približno 11 %). Le majhen delež učencev je navedel zgolj 1 jezik ali 2 jezika (skoraj 5 %). Prav tako je zgolj malo učencev (približno 5 %) navedlo 8 jezikov ali več. Na podlagi teh rezultatov lahko trdimo, da večina učencev v svoj jezikovni repertoar vključuje 4 jezike do 7 jezikov. Ta podatek razumemo kot pokazatelj tega, da učenci večjezičnost razumejo kot odprto polje in da intuitivno zaznavajo, da so večjezične kompetence lahko različno razvite in ne dosegajo nujno vedno samo zelo visokih ravni.
Zanimalo nas je, ali prihaja do razlik med učenci v številu jezikov glede na to, ali obiskujejo šolo na narodno mešanem območju ali drugje v Sloveniji.

Tabela 4: Izid χ^2-preizkusa v številu jezikov glede na model osnovne šole.

Število jezikov		**Model OŠ: narodno mešano območje**	**Model OŠ: drugje**	**Izid χ^2-preizkusa**
0	f	0	2	
	f %	0,0	0,5	
1	f	0	1	
	f %	0,0	0,3	
2	f	4	20	
	f %	2,3	5,5	
3	f	17	45	
	f %	9,6	12,3	
4	f	40	84	χ^2 = 8,945
	f %	22,6	23,0	P = 0,835
5	f	42	77	
	f %	23,7	21,1	
6	f	28	46	
	f %	15,8	12,6	
7	f	38	70	
	f %	21,5	19,2	
8 ≥	f	8	20	
	f %	4,5	5,5	

Izid χ^2-preizkusa kaže, da ne prihaja do statistično značilnih razlik med učenci v številu jezikov glede na model osnovne šole. Koliko jezikov učenci vključujejo v svoj jezikovni repertoar, torej ni odvisno od tega, ali učenci obiskujejo šolo na narodno mešanem območju ali drugje v Sloveniji. Rezultat preseneča, saj smo izhajali iz dejstva, da bodo učenci, ki obiskujejo šolo na narodno mešanem območju, navajali več jezikov; ti se namreč poleg tujih jezikov učijo še madžarščino oz. italijanščino.

Po drugi strani pa rezultat kaže ravno na zgoraj omenjeno odprtost do jezikov. Učenci so na portretih vključevali tudi jezike, ki jih slabo obvladajo, imajo pa trenutno neko vlogo v njihovem vsakdanjiku.
V nadaljevanju smo hoteli ugotoviti, katere jezike bodo učenci navajali pri izdelavi jezikovnih portretov.

Tabela 5: Število (f) in strukturni odstotki (f %) učencev po jeziku.

Jeziki	**f**	**f %**
Angleščina	512	94,5
Slovenščina	**505**	**93,2**
Hrvaščina	328	60,5
Nemščina	315	58,1
Italijanščina	**255**	**47,0**
Drugi jeziki	157	29,0
Španščina	152	28,0
Francoščina	136	25,1
Bosanščina	84	15,5
Madžarščina	**77**	**14,2**
Srbščina	53	9,8
Narečje	53	9,8
Ruščina	32	5,9
Albanščina	20	3,7
Makedonščina	15	2,8

Iz preglednice 5 lahko razberemo, da učenci pri izdelavi jezikovnih portretov niso največkrat navedli – kot smo pričakovali – slovenščine (približno 93 %), temveč angleščino (skoraj 95 %). Čeprav je procentualna razlika med jezikoma izredno majhna, ta rezultat kljub temu preseneča. Domnevamo, da ima angleščina kot t. i. lingva franka v večini slovenskih osnovnih šol visok ugled, kar je povezano tudi s tem, da se je večina učencev uči kot obvezni prvi tuji jezik. Ker se učenci jezikov ne učijo zgolj v sklopu učnega procesa, temveč tudi preko spleta, televizije, radia ipd., moramo na te mestu opozoriti tudi na vpliv medijev. Ob angleščini lahko na te mestu izpostavimo tudi naslednje jezike: nemščina, španščina in hrvaščina. S spremljanjem nemških oz. avstrijskih televizijskih programov, hrvaške glasbe ter t. i. »španskih nadaljevank« postajajo tudi ti jeziki del vsakdanjika učencev. Na slednje opozarja npr. sledeč komentar učenke:

– *»Sem izbrala, ker znam nekaj iz španskih serij.«*

Pogostokrat so bili navedeni tudi jeziki sosednjih držav in s tem tudi oba jezika narodno mešanega območja: hrvaščina (skoraj 61 %), nemščina (približno 58 %) in italijanščina (47 %). V primerjavi s temi je bila madžarščina navedena v manjšem procentualnem obsegu (približno 14 %). Čeprav madžarščina in italijanščina veljata kot uradna jezika na narodno mešanem območju Slovenije, rezultati nakazujejo, da se večina učencev bolj identificira z jezikoma drugih dveh sosednjih držav.
Kot nakazujejo spodnji komentarji, razlog za to, zakaj večina učencev (skoraj 61 %) v svoj jezikovni portret vključuje hrvaščino, verjetno leži v tem, ker jezik povezujejo z različnimi izvenjezikovnimi dejavniki (npr. s počitnicami) in ker opažajo podobnosti med hrvaščino in slovenščino:

– *»Hodim tja na morje in se učim tega jezika.«*
– *»(…), ker grem vsako poletje na hrvaško na morje.«*
– *»Podoben je slovenščini.«*

Poleg hrvaščine so sestavni del jezikovnih portretov bili tudi drugi jeziki bivše Jugoslavije: bosanščina (skoraj 16 %), srbščina (skoraj 10 %), albanščina (skoraj 4 %) in makedonščina (skoraj 3 %). Razlog za to verjetno leži v tem, ker veliko migrantov, ki živi v Sloveniji, prihaja iz držav bivše Jugoslavije.
Tudi narečje je bilo večkrat navedeno (skoraj 10 %), kar nakazuje na to, da se učenci zavedajo, da v svojem vsakdanjiku uporabljajo različne jezikovne zvrsti slovenščine. Kot prikazuje preglednica 5, smo v analizo vključili 14 jezikov, to pa ne pomeni, da so učenci navajali zgolj te. Druge jezike je navedlo 29 % učencev, vendar smo jih zaradi lažje analize uvrstili v eno kategorijo. Visok procentualni delež te kategorije pa kljub temu nakazuje na že navedeno dejstvo o odprtosti do jezikov in o razumevanju večjezičnosti.

Razlike v navedenih jezikih glede na model osnovne šole prikazuje preglednica 6.

Tabela 6: Izidi χ^2-preizkusa v jezikih glede na model osnovne šole.

Jeziki		**Model OŠ: narodno mešano območje**	**Model OŠ: drugje**	**Izid χ^2-preizkusa**
Slovenščina	f	**163**	**342**	**χ^2 = 0,485**
	f %	**92,1**	**93,7**	**p = 0,486**
Angleščina	f	165	347	χ^2 = 1,531
	f %	93,2	95,1	p = 0,465
Nemščina	f	90	225	χ^2 = 5,708
	f %	50,8	61,6	p = 0,017
Španščina	f	44	108	χ^2 = 1,322
	f %	24,9	29,6	p = 0,250
Hrvaščina	f	90	238	χ^2 = 10,364
	f %	50,8	65,2	p = 0,006
Bosanščina	f	49	35	χ^2 = 29,800
	f %	27,7	9,6	p = 0,000
Srbščina	f	24	29	χ^2 = 4,258
	f %	13,6	7,9	p = 0,039
Makedonščina	f	10	5	χ^2 = 8,114
	f %	5,6	1,4	p = 0,004
Albanščina	f	8	12	χ^2 = 0,509
	f %	4,5	3,3	p = 0,476
Francoščina	f	26	110	χ^2 = 15,133
	f %	14,7	30,1	p = 0,000
Ruščina	f	9	23	χ^2 = 0,301
	f %	5,1	6,3	p = 0,583
Madžarščina	f	**58**	**19**	**χ^2 = 74,297**
	f %	**32,8**	**5,2**	**p = 0,000**
Italijanščina	f	**115**	**140**	**χ^2 = 34,700**
	f %	**65,0**	**38,4**	**p = 0,000**
Narečje	f	16	37	χ^2 = 0,163
	f %	9,0	10,1	p = 0,687
Drugi jeziki	f	45	112	χ^2 = 1,604
	f %	25,4	30,7	p = 0,205

Statistično značilne razlike se kažejo pri naslednjih jezikih: nemščina (χ^2 = 5,708; P = 0,017), hrvaščina (χ^2 = 10,364; P = 0,006), bosanščina (χ^2 = 29,800; P = 0,000), srbščina (χ^2 = 4,258; P = 0,039), makedonščina (χ^2 = 8,114; P = 0,004), francoščina (χ^2 = 15,133; P = 0,000), madžarščina (χ^2 = 74,297; P = 0,000) in italijanščina (χ^2 = 34,700; P = 0,000).

Učenci, ki so v jezikovnih portretih navajali jezike bivše Jugoslavije – v tem primeru so to bosanščina, srbščina in makedonščina – v večji meri obiskujejo osnovne šole na narodno mešanem območju. Ta podatek se sklada s podatki Statističnega urada Republike Slovenije (2018), kajti v obalno-kraški regiji med priseljenci, ki so v Slovenijo migrirali iz bivše Jugoslavije, prevladujejo priseljenci iz Bosne in Hercegovine (34 %). Statistični podatki pa prav tako nakazujejo, da v pomurski regiji med priseljenci prevladujejo tisti s prvim prebivališčem na Hrvaškem (36 %; prav tam), kljub temu pa učenci, ki so v jezikovnem portretu omenili hrvaščino, v večji meri obiskujejo osnovne šole drugje v Sloveniji. Kako to pojasniti? Ker je skoraj 61 % učencev v svojem jezikovnem portretu označilo hrvaščino kot svoj izbor jezika (gl. preglednico 5), domnevamo, da hrvaščine niso označili zgolj učenci, katerih prvi (oz. drugi) jezik je hrvaščina, temveč tudi drugi učenci; ti hrvaščino – kot smo omenili že prej – najverjetneje povezujejo tudi z drugimi, izvenjezikovnimi dejavniki, npr. s počitnicami na Hrvaškem, hrvaško glasbo, jezikovno bližino med slovenščino (oz. katerim drugim jezikom bivše Jugoslavije) in hrvaščino ipd.

Kot pričakovano, so učenci, ki obiskujejo osnovne šole na narodno mešanem območju, večkrat navajali madžarščino in italijanščino. Rezultat nas ni presenetil, saj imata madžarščina in italijanščina na narodno mešanem območju poleg slovenščine status uradnega jezika.

V raziskavi smo tudi ugotoviti, na katero mesto v legendi ob silhueti so učenci postavili posamezne jezike.

Tabela 7: Aritmetične sredine ($\bar{x}$) glede na dodeljeno mesto jezika.

Rang	Jeziki:	$\bar{x}$
1.	**slovenščina**	**1,8**
2.	albanščina	2,4
3.	angleščina	2,6
4.	**madžarščina**	**3,2**
5.	bosanščina	3,3
6.	makedonščina	3,5
7.	nemščina	3,6
8.	**italijanščina**	**3,8**
9.	hrvaščina	3,9
10.	drugi jeziki	4,3
11.	narečje	4,4
12.	španščina	4,6
13.	francoščina	4,6
14.	ruščina	4,6
15.	srbščina	5,1

Iz preglednice 7 lahko razberemo, da so učenci slovenščino – kljub dejstvu, da ni bila največkrat navedena (gl. preglednico 5) – najpogosteje uvrstili na 1. mesto. Visoka mesta so bila dodeljena tudi albanščini in angleščini. Madžarščina je pristala na 4. mestu. Sledijo ji bosanščina, makedonščina in nemščina. Na 8. mestu je pristala italijanščina. Tej sledijo hrvaščina, drugi jeziki in narečje. Spodnja mesta pa zasedajo španščina, francoščina, ruščina in srbščina.

Statistično značilne razlike v dodeljenem mestu jezika glede na model osnovne šole prikazuje preglednica 8.

Tabela 8: Izidi Mann-Whitneyjevega U-preizkusa (M-W) razlik v dodeljenem mestu jezika glede na model osnovne šole.

Jezik	**Model OŠ:**	**r**	**Izidi M-W-preizkusa**	
			u	**p**
Slovenščina	**drugje**	**261,39**	**28614,0**	**0,017**
	nar. mešano ob.	**292,34**		
Albanščina	drugje	270,17	31818,0	0,374
	nar. mešano ob.	274,24		
Angleščina	drugje	245,32	22748,5	0,000
	nar. mešano ob.	325,48		
Madžarščina	**drugje**	**248,23**	**23810,0**	**0,000**
	nar. mešano ob.	**319,48**		
Bosanščina	drugje	255,61	26502,5	0,000
	nar. mešano ob.	304,27		
Makedonščina	drugje	267,72	30924,0	0,005
	nar. mešano ob.	279,29		
Nemščina	drugje	272,49	31939,5	0,824
	nar. mešano ob.	269,45		
Italijanščina	**drugje**	**257,93**	**27348,0**	**0,002**
	nar. mešano ob.	**299,49**		
Hrvaščina	drugje	274,36	31258,0	0,526
	nar. mešano ob.	265,60		
Drugi jeziki	drugje	276,22	30579,5	0,206
	nar. mešano ob.	261,77		
Narečje	drugje	272,23	32035,0	0,761
	nar. mešano ob.	269,99		
Španščina	drugje	275,54	30827,5	0,276
	nar. mešano ob.	263,17		
Francoščina	drugje	283,44	27946,0	0,001
	nar. mešano ob.	246,89		
Ruščina	drugje	272,33	31998,5	0,659
	nar. mešano ob.	269,78		
Srbščina	drugje	266,23	30378,5	0,028
	nar. mešano ob.	282,37		

Statistično značilne razlike se pojavljajo pri naslednjih jezikih: slovenščina (U = 28614,0; P = 0,017), angleščina (U = 22748,5; P = 0,000), madžarščina (U = 23810,0; P = 0,000), bosanščina (U = 26502,5; P = 0,000), makedonščina (U = 30924,0; P = 0,005), italijanščina (U = 27348,0; P = 0,002), francoščina (U = 27946,0; P = 0,001) in srbščina (U = 30378,5; P = 0,028).
Učenci, ki obiskujejo osnovne šole na narodno mešanem območju, so višja mesta dodeljevali madžarščini, italijanščini in – kot so že nakazovali rezultati iz preglednice 6 – jezikom bivše Jugoslavije (bosanščina, makedonščina in srbščina). Domnevamo, da veliko migrantov iz bivše Jugoslavije migrira na mejna območja, priseljenci iz Bosne in Hercegovine zlasti na narodno mešano območje slovenske Istre (gl. Statistični Urad Republike Slovenije, 2018).
Zakaj so učenci, ki obiskujejo osnovne šole na narodno mešanem območju, dodeljevali višja mesta madžarščini, pojasnjujejo tako:

- *»Moj materni jezik, moj drugi jezik.«*
- *»Ker je moj materni jezik, ga zelo tekoče govorim.«*

Madžarščina se torej povezuje z jezikom, s katerim se učenci identificirajo in ki ga dobro obvladajo. Rezultati študije Medvešek in Bešter (2016, str. 176) o etnični, jezikovni in kulturni raznolikosti v izbranih naseljih narodno mešanega območja v Prekmurju (Hodoš, Dolnji Lakoš in Radmožanci) prav tako nakazujejo, da večina anketiranih (64 %) madžarščino opredeljuje kot svoj materni jezik, polovica manj (32 %) pa slovenščino.
Na tem mestu je treba opozoriti tudi na učence, ki pripadajo etnični skupini Romov – prvi njihov jezik namreč ni slovenščina oz. madžarščina, temveč romščina:

- *»Jezik poznam, ker je moj materni jezik.«*

Učenci, ki obiskujejo osnovne šole na narodno mešanem območju, so dodeljevali višja mesta tudi italijanščini. V nasprotju z madžarščino, ki jo učenci povezujejo s svojim prvim oz. drugim jezikom, italijanščina za učence predstavlja jezik, ki se ga učijo (npr. v šoli, preko medijev, s pomočjo staršev itd.). Glede na omenjeni večjezični model (Franceschini 2001) italijanščina torej za večino učencev ne predstavlja centralnega jezika, temveč jezik periferije:

- *»Učim se jo v šoli in mami, ko se z njo učim, izvem tudi kaj drugega.«*
- *»Italiano perche la parla o scuola. Ta jezik poznam, a ga malo uporabljam.«*
- *»Jezik zelo dobro poznam, ker gledam italijanske programe. Naučim se veliko novih italijanskih besed in tudi malo težje.«*

To podpirajo tudi spodnji komentarji, da se učenci, ki obiskujejo osnovne šole na narodno mešanem območju slovenske Istre (Koper in Izola), bolj identificirajo s slovenščino (centralni jezik) kot z italijanščino (jezik periferije):

- *»Zame Italijanščina ni tako zelo pomembna. Pobarvala sem malo manj kot za Slovenščino, ker znam veliko Italijanščine (še vedno manj od Slovenščine).«*
- *»Moj materni jezik in z očetom, bratom in z mamo govorimo tako doma.«*
- *»Ta jezik sem izbrala, ker je to moj materni jezik in ga obvladam. Zato ker ga govorim že od malega. Najbolj mi gre.«*
- *»Moj materni jezik, Sloveno perche è la ma lingue madre.«*

Ti rezultati sovpadajo z rezultati raziskave (Kompara 2014), ki opozarja na to, da učenci, ki so sposobni delovati v obeh jezikih na enak način, predstavljajo zelo majhno število prebivalcev narodno mešanega območja slovenske Istre. Učitelji, ki poučujejo na različnih slovenskih osnovnih in srednjih šolah na narodno mešanem območju slovenske Istre, trdijo celo, da mladi, rojeni po letu 1990, ne morejo biti identificirani kot dvojezični posamezniki. Razlog za to je mogoče najti v številnih vidikih, zlasti pa v razvoju novih tehnologij in širokem naboru televizijskih programov v angleškem jeziku, ki izpodriva italijanske (prav tam, str. 96–97). Na to nas opozarja tudi rezultat pričujoče raziskave (gl. preglednico 5).
Glede na to, da so učenci navedene jezike označevali v obris človeškega telesa, nas je prav tako zanimalo, kateri del telesa povezujejo s katerim jezikom.

Tabela 9: Število (f) in strukturni odstotki (f%) učencev glede na to, kateri del telesa so dodelili jezikom.

	Del telesa:													
	glava		**srce**		**trup**		**roke**		**noge**		**celotno**		**drugo**	
Jezik	**f**	**f%**	**f**	**f%**	**f**	**f%**	**f**	**f%**	**f**	**f%**	**f**	**f%**	**f**	**f%**
Slovenščina	**252**	**49,9**	**19**	**3,8**	**279**	**55,2**	**230**	**45,5**	**217**	**43,0**	**1**	**0,2**	**18**	**3,6**
Angleščina	113	22,1	9	1,8	162	31,6	203	39,6	242	47,3	1	0,2	15	2,3
Nemščina	55	17,5	1	0,3	75	23,8	94	29,8	147	46,7	1	0,3	8	2,5
Španščina	16	10,5	3	2,0	31	20,4	40	26,3	80	52,6	0	0,0	6	3,9
Hrvaščina	60	18,3	3	0,9	84	25,6	99	30,2	167	50,9	0	0,0	9	2,7
Bosanščina	26	31,0	3	3,6	31	36,9	28	33,3	34	40,5	0	0,0	0	0,0
Srbščina	12	22,6	0	0,0	13	24,5	15	28,3	29	54,7	0	0,0	0	0,0
Makedonščina	5	33,3	2	13,3	3	20,0	9	60,0	4	26,7	0	0,0	0	0,0
Albanščina	7	35,0	3	15,0	7	35,0	4	20,0	10	50,0	0	0,0	0	0,0
Francoščina	20	14,7	0	0,0	17	12,5	41	30,1	75	55,1	0	0,0	4	2,9
Ruščina	9	28,1	1	3,1	5	15,6	8	25,0	18	56,3	0	0,0	2	6,3
Madžarščina	**13**	**16,9**	**2**	**2,6**	**28**	**36,4**	**28**	**36,4**	**33**	**42,9**	**0**	**0,0**	**2**	**2,6**
Italijanščina	**32**	**12,5**	**1**	**0,4**	**39**	**15,3**	**71**	**27,8**	**134**	**52,5**	**0**	**0,0**	**10**	**3,9**
Narečje	11	20,8	0	0,0	15	28,3	16	30,2	30	56,6	0	0,0	3	5,7
Drugi jeziki	25	15,9	1	0,6	36	22,9	37	23,6	78	49,7	0	0,0	6	3,8

Kot prikazuje preglednica 9, učenci slovenščino največkrat povezujejo s trupom (približno 55 %), glavo (skoraj 50 %), rokami (skoraj 46 %) in nogami (43 %). To ena od učenk pojasnjuje takole:

– *»Roke, glavo in trup sem pobarvala, ker so to zame najpomembnejši deli telesa. Največ sem pobarvala za Slovenščino, ker je to moj materni jezik.«*

Večina jezikov je bila dodeljena nogam: angleščina (približno 47 %), nemščina (skoraj 47 %), španščina (skoraj 53 %), hrvaščina (skoraj 51 %), bosanščina (skoraj 41 %), srbščina (skoraj 55 %), albanščina (50 %), francoščina (približno 55 %), ruščina (približno 56 %), madžarščina (skoraj 43 %), italijanščina (skoraj 53 %), narečje (skoraj 57 %) in drugi jeziki (skoraj 50 %).
Makedonščino so učenci največkrat označili v predelu rok (60 %). Predel rok in trup sta bila večkrat označena tudi pri naslednjih jezikih: angleščina (roke: skoraj 40 %, trup: skoraj 32 %), bosanščina (roke: približno 33 %, trup: skoraj 37 %) in madžarščina (roke in trup: približno 36 %).

Če povzamemo, lahko trdimo, da učenci jezike največkrat povezujejo z gibljivimi deli telesa. Izstopa pa dejstvo, da je slovenščina – v primerjavi z drugimi jeziki – večkrat označena tudi na področju glave.
Posebno pozornost smo namenili tudi predelu srca. Kot kaže preglednica 9, je zelo malo učencev navedene jezike uvrstilo v predel srca. V predel srca so učenci uvrstili albanščino (15 %) in makedonščino (približno 13 %). Ker je bila madžarščina velikokrat označena v predelu trupa, bi lahko trdili, da učenci tudi madžarščino povezujejo s predelom srca. Slovenščina je bila tudi nekajkrat (skoraj 4 %) označena v predelu srca. Glede na komentarje posameznih učencev lahko trdimo, da učenci srce povezujejo s svojim poreklom in prvim jezikom:

- *»Slovenija je na srcu, saj je moja domovina.«*
- *»Saj je [slovenščina] moj materni jezik in je blizu srca.«*
- *»Albanščina je moj materni jezik zato sem ga narisal zraven srca.«*

Sklep

Rezultati empirične raziskave prikazujejo, da se jezikovni repertoar med učenci, ki obiskujejo osnovne šole na narodno mešanem območju slovenske Istre (Koper in Izola) in Prekmurja (Dobrovnik in Lendava), in učenci, ki obiskujejo osnovne drugje v Sloveniji (Ljubljana, Maribor, Vipava, Fokovci, Slovenske Konjice, Trbovlje, Škofja Loka), razlikujejo. Pričakovano so učenci, ki obiskujejo osnovne šole na narodno mešanem območju, v svojem jezikovnem portretu pomembno mesto namenili manjšinskima jezikoma – madžarščini oz. italijanščini. Kljub temu izstopa dejstvo, da je bila madžarščina v odnosu s prvim oz. drugim jezikom učencev večkrat postavljena na enakovreden nivo pomembnosti. Ta rezultat utemeljujemo z dvojezičnim modelom nekaterih osnovnih šol na narodno mešanem območju Prekmurja, kjer se učni proces izvaja tako v slovenščini kot v madžarščini. Na nekaterih osnovnih šolah na narodno mešanem območju slovenske Istre je italijanščina sicer obvezen učni predmet, učni proces pa kljub temu ostaja enojezičen. Menimo, da ta model neposredno vpliva na to, da učenci, katerih prvi (in drugi) jezik ni italijanščina, italijanščine ne smatrajo kot svoj centralni jezik, temveč kot jezik periferije (gl. Franceschini, 2001).

Ti rezultati sovpadajo z rezultati raziskave Kompara (2014), ki opozarja na to, da učenci, ki so sposobni delovati v obeh jezikih na enak način, predstavljajo zelo majhno število prebivalcev narodno mešanega območja slovenske Istre. Kompara trdi (prav tam, str. 96–97), da je razlog za to mogoče najti v razvoju novih tehnologij in širokem naboru televizijskih programov v angleškem jeziku, na kar nas opozarjajo tudi rezultati pričujoče raziskave (gl. preglednico 5). Rezultate pričujoče empirične raziskave lahko povežemo tudi s podatki Statističnega urada Republike Slovenije (2018) o priseljencih iz Bosne in Hercegovine (in najverjetneje tudi iz nekaterih drugih držav bivše Jugoslavije) na območju slovenske Istre, saj so učenci, ki obiskujejo osnovne šole na narodno mešanem območju slovenske Istre, poleg slovenščine in italijanščine navajali tudi jezike bivše Jugoslavije (bosanščina, makedonščina in srbščina).

Summary

Article 11 of the Constitution of the Republic of Slovenia (2016) states that Slovene is the official language of Slovenia. Additionally, in municipalities where either the Italian or the Hungarian national community resides, the Italian or Hungarian language, respectively, also has official status. For the educational sphere and process, this means that Slovene and Italian and Slovene and Hungarian appear in different roles in nationally diverse regions. They are considered as (1) language(s) of instruction (language(s), in which the educational process takes place, and/or as (2) a curriculum subject. In the region where the Italian national community resides (the littoral municipalities of Ankaran, Izola, Koper, and Piran), education takes place in either Italian or Slovene. In the nationally diverse region where the Hungarian national community resides (Prekmurje), bilingual education is compulsory by law (Straus, 2018, p. 14). In the bilingual model applied in this part of the country, both Hungarian and Slovene take on the role of language of instruction and curriculum subject (Ibid., p. 68).

The main aim of this article is to determine the extent of differences between pupils in nationally diverse regions (Slovenian Istria and Prekmurje) and pupils in other parts of the country with regard to: 1) which languages they include in their linguistic repertory and to what degree; 2) in what relation they put the languages towards each other; and 3) how they explain their respective linguistic choices.

The empirical research featured a qualitative and partially quantitative analysis of language portraits (research instrument), which 5th grade students from primary schools in nationally diverse regions and other parts of the country (survey sample) created as part of the research project "Jeziki štejejo/Languages Matter" (academic year 2018/2019). Language portraits represent a special research instrument in the form of a piece of paper featuring a silhouette of the human body, with empty boxes for the legend key arrayed along the right side. Language portraits are a means to help students in expressing their attitudes towards languages by connecting them to individual parts of the body. In addition, the students can explain their choices if they desire. A total of 542 5th-grade students participated in the project, of which 177 (32.7%) were enrolled in primary schools from nationally diverse regions, while the remaining 365 (67.3%) were enrolled in primary schools from other parts of the country. As part of the empirical study, we conducted quantitative research on which and how many languages the students had marked specifically and to which parts of the human body they assigned these. In this regard, we determined possible differences between the students based on their enrollment in primary school either in nationally diverse regions or in other parts of the country, using SPSS statistical software. If students enrolled in primary school in nationally diverse regions included additional comments or explanations about why they had chosen Slovene, Hungarian, and /or Italian and for what reason they had assigned the languages mentioned to a particular body part, we subjected these comments or explanations to qualitative analysis.

The results show that the majority of the students included between four (4) and seven (7) languages in their linguistic repertory. We consider this finding as an indicator that students understand multilingualism as an open field, that they intuitively perceive that multilingual competences can be developed to various degrees, and that they are aware that language competences do not necessarily always develop to a very high level.

Contrary to our expectations, the students most frequently highlighted English (95%) and not Slovene (93%) in their language portraits. They also frequently chose languages of the neighbouring countries, including both languages of the nationally diverse regions observed in the study: Croatian (almost 61%); German (58%); and Italian (47%). In comparison, Hungarian (14%), was chosen to a lesser degree.

Students enrolled in primary school in nationally diverse regions ranked Hungarian, Italian, and languages spoken throughout the former Yugoslavia (Bosnian, Macedonian, and Serbian in particular) the highest. This fact corresponds with the data from the Statistical Office of the Republic of Slovenia (2018). Many migrants from the former Yugoslavia have settled in the Slovenian Istria region. Although students enrolled in primary school in nationally diverse regions ranked the aforementioned languages the highest, for most of them Italian only represents a language they learn (e. g. in school, through the media, with the help of their parents etc.), in contrast to Hungarian, which students consider as either their first or second language. Based on Rita Franceschini's (multi)language model (2001), Italian does not represent the central language for most students but rather a peripheral one. We link this finding to the bilingual model applied by some primary and lower secondary schools in the nationally diverse region of Prekmurje, where education takes place in both Slovene and Hungarian. On the other hand, even though Italian is a compulsory curriculum subject in some primary and lower secondary schools in the nationally diverse region of Slovenian Istria, the education process remains monolingual.

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SIGNS OF A CATASTROPHE: PREDICTED SHORTAGE OF TEACHERS OF LOWER SECONDARY SCIENCE AND TECHNICS AND TECHNOLOGY IN SLOVENIA

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Abstract/Izvleček The paper provides evidence as a baseline for action to prevent the educational catastrophe that would result from the predicted shortage of STEM teachers in lower secondary schools in Slovenia. Based on the data, obtained from the relevant institutions, we can predict that, without a change in educational policy towards encouraging students to choose the teaching of STEM subjects as a career, the number of STEM teachers will fall below all acceptable levels.

Katastrofa na vidiku: predvideno je veliko pomanjkanje učiteljev naravoslovnih in tehničnih predmetov v slovenskih osnovnih šolah Prispevek predstavlja dokaze kot izhodišče za ukrepe, ki preprečujejo katastrofo v izobraževanju z napovedanim pomanjkanjem učiteljev naravoslovnih predmetov in Tehnike in tehnologije (TIT) osnovnih šol v Sloveniji. Na podlagi podatkov, pridobljenih na ustreznih institucijah, lahko predvidimo, da bo, brez spremembe izobraževalne politike, število učiteljev naravoslovnih predmetov in TIT padlo pod vse sprejemljive ravni. Edina rešitev, ki ohranja kakovost naravoslovnega in tehniškega izobraževanja, je povečanje števila študentov na omenjenih pedagoških študijskih programih. Predlagana rešitev potrebuje resno vladno podporo v obliki kadrovskih štipendij.

Keywords:
STEM teacher shortage, lower secondary schools, the economics of education

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Introduction

There is probably no need to argue the importance for any society of having citizens well educated in Science, Technology, Engineering, and Mathematics (hereafter STEM) and proficient in Information and Communication Technology (ICT). Therefore, if societies need such profiles, they need to attract enough students to enrol in study and qualification programmes leading to the desired professions. Moreover, as has often been recognized, the main challenge does not lie in building brick and mortar buildings or buying equipment; the problem lies in the provision of qualified employees to work inside those buildings and work with the equipment installed. To paraphrase what has been written, if societies need STEM-educated citizens, then they should make all necessary effort to create enough well-educated teachers to provide this instruction at all educational levels. Small countries like Slovenia face three interconnected problems regarding STEM education (Ploj Virtič et al. 2017):

1. How to attract enough students to enter STEM studies, especially at higher educational levels;
2. How to attract enough students to enter programmes for pre-service STEM teachers;
3. How to prevent brain drain.

The present paper addresses only the problem of attracting a sufficient number of students who want to become STEM teachers.

The arguments about the importance of including science in curricula were elaborated by Millar (2002), and these arguments can be applied to all STEM disciplines, as well. We would like to emphasize the intrinsic and instrumental arguments as provided by Millar (p.115), so we have chosen to cite these verbatim:

»(1) Intrinsic justification

Scientific knowledge is a cultural product of great intellectual power and beauty. Humans have a curiosity about the natural world which scientific knowledge can help to satisfy. Many people have found the pursuit of science personally satisfying and rewarding.

(2) Instrumental justification

Scientific knowledge is necessary to:

- *make informed practical decisions about everyday matters;*

- *participate in decision-making on issues which have a scientifically technological component;*
- *work in jobs which involve science and technology (at various levels)«.*

Because of the complexity stemming from the nature of science and scientific reasoning, STEM education at the primary and secondary school levels cannot be left to self-educated dilettantes. Good teaching requires teachers able to combine knowledge and pedagogy in Pedagogical Content Knowledge (PCK) (Shulman, 1986) and to utilize their PCK and its associated Technological Pedagogical Content Knowledge (TPCK) (Koehler & Mishra, 2006). To summarize, one of the most important key ingredients in the educational system is a well-educated STEM teacher. This is especially important in a period of rapid change when new knowledge is not only added to the existing corpus but is replacing old paradigms, new technologies are replaced even before they have been fully explored, and the teacher must be prepared for and flexible in adapting to these changes.
The aim of the study is to provide evidence as a baseline for taking action to prevent the educational catastrophe resulting from the predicted shortage of STEM teachers in lower secondary schools in Slovenia.

Overview of the teacher shortage problem in Europe
The shortage of teachers, especially those for STEM and ICT, is a well-known global problem recognized by many. In the documents of prominent international organizations such as the OECD, one can recognize warnings, such as: "In 15 out of 19 OECD countries, most primary teachers are at least 40 years old, and in Germany, Italy and Sweden, more than one third of teachers are older than 50 years" (OECD 2003 pp. 403), and nobody can say that there has been insufficient information to act to solve this problem. According to the 2003 edition of the OECD's Education at a Glance, teacher shortages may become a policy challenge for many OECD countries in the years to come, as student enrolment levels rise, while older teachers retire and not enough younger people join the profession. However, it seems that there is a lack of will among decision-makers to make a change because the problem has only worsened.

The Eurydice study Key Data on Education in Europe 2012 (Eurydice, 2012) states that, given the serious shortage of qualified teachers for core subjects, an average of 15% of 15-year old students were taught in schools where teaching was hindered to some extent by a lack of qualified science and mathematics teachers. This finding is alarming, since the teacher is one of the key factors influencing the selection of engineering and mathematics for further study (Dick, & Rallis, 1991). Therefore, it is necessary to make sure that STEM is taught by good teachers who will impress young people in STEM classes with their approach and way of teaching because "findings indicate that, overall, youth who are activated towards science learning are more likely to have affinity towards STEM careers, certainty about their future career goals, and have identified a specific STEM career goal" (Dorph et al., 2018, p. 1034). Years later, the European Centre for Development of Vocational Training (Cedefop, 2016) published their findings on the most in-demand occupations in Europe. They wrote (p. 1), "Across the European Union (EU), MPOs (Mismatch priority occupations are those for which a critical shortage, or surplus, has important implications for the national economy and for education and training) for which there are skill shortages are a mix of regulated and non-regulated professional and associate professional occupations at higher skill levels. The top five skills are ICT professionals; medical doctors; science, technology, engineering and mathematics (STEM) professionals; nurses and midwives; and teachers". To be honest, the shortage of STEM teachers did not affect all countries equally, and some countries did not share the problem (OECD 2003). On the other hand, in some countries, Slovenia included, there can be a surplus of teachers in one subject and a simultaneous shortage of teachers in another subject, a problem that must be resolved by each country separately. The reasons for the shortage are different in each country included in the study, but the most common reasons are the negative public image and low salaries, compared to similarly educated professionals, and at higher levels of education, that the study programs are lengthy and highly selective (Ploj Virtič et al. 2017).

In their Joint Report, the European Commision (2015) pointed out several challenges that national policy will have to address. One of these was a serious shortage of teachers, owing to the ageing population, geographical factors, or social background.

However, the response of the authorities in those countries that have a shortage of STEM teachers was not to pump resources into encouraging youth to think about entering teaching careers, but to use existing reserves to upskill existing employees. In extreme cases, teachers of literally any subject could teach subjects in which they were unqualified (Act of Amendments of Organisation and Financing of Education Act, 2003). Identifying the problem is not the same as solving it. One of the main findings from the Eurydice (2018) report, Teaching Careers in Europe: Access, Progression and Support, is that the most common challenges concerning teacher demand and supply in Europe involve teacher shortages and ageing teacher populations. They also report that the planning of teacher supply and demand is usually carried out annually. Most education systems in EU countries (26 countries) have some form of planning, but only seven have long-term planning (Eurydice, 2018). The Eurydice report is consistent with the OECD report, Education at a Glance 2017 (OECD, 2017), in which similar claims are made. In most EU countries, the teaching profession is less and less appealing for young people, owing to its low salaries compared to similarly educated professionals, highly selective and lengthy study programs and the phenomenon of children and learning environments that have become more demanding. To summarize, the problems are well known, and solutions have been proposed; however, action to solve these problems is still missing.

Education in Slovenia

For a better understanding of the problem, the Slovenian pre-tertiary school system, its duration, and the required education for teaching each level, are presented in Table 1. Nine-year elementary school is compulsory for all citizens of Slovenia.

Table 1: Slovenian pre-tertiary school system, including duration and education required for teaching each level.

Level of school	**Duration**	**Type of school**	**Education required for teaching**
Secondary school: starting at age 15	3 or 4 years	Upper secondary school (general or vocational)	Subject teachers
Elementary school: starting at age 6	4 years	Lower secondary school	Subject teachers, usually teaching two subjects (math, physics, chemistry, history, technics & technology, and sport)
	5 years	Primary school	Primary teachers (one teacher covers all subjects)

Requirements for teaching in Slovenian primary and secondary schools

Recently, the entrance criteria for enrolling in teaching in Slovenian public school have been set at a Master's level programme, including at least 60 ECTS (European Credit Transfer and Accumulation System) points in pedagogical subjects and teaching practice in school.

The next option is to finish a Master's level programme in basic science or engineering with an additional one-year course with 60 ECTS in pedagogical subjects. This option is most often used by teachers of subjects in the mathematics, ICT, science and technical-engineering disciplines at upper secondary schools who, because of a shortage of qualified teachers, were employed at schools and given the chance to acquire teacher qualification. For some teachers, mostly at vocational schools, this is the only option because such an educational programme is not offered (e.g. for teaching veterinary subjects at secondary school).

Professional teacher education is offered by the following institutions:

a) Faculties of Education – these offer a one-stream programme for elementary teachers and two-stream programmes for subject teachers, with later primary occupation in primary schools.
b) Professional one- or two-stream pedagogical programmes offered by faculties where the primary programmes are scientific (e.g. Biology, Physics, Chemistry, Mathematics), pedagogical programmes offered at the Faculties of Arts.

A case study of the Slovenia STEM teacher shortage

Slovenia is one of the few EU countries that lacks any form of planning for the teaching profession at any level of education (Eurydice, 2018). This finding should be surprising, given the numerous governmental institutions dealing with the education of a relatively small student population and the low number of institutions that educate future STEM teachers. Moreover, in Slovenia, there are only about 450 nine-year public compulsory elementary schools and fewer than 200 upper secondary schools, in addition to a small number of private schools.

On the other hand, Slovenia's demand for the required minimum level of teacher education is among the highest in Europe (Eurydice, 2012).

Even more, a report on Slovenian national policy indicates an oversupply of teachers: "In Slovenia, the demand for teachers has fallen in recent years due to a population decrease, the economic crisis and austerity measures. A measure to tackle the oversupply of teachers is the project First Employment in Education which aims to support the employment of young first-time job-seeking teachers or counselling specialists. Estimated funds in 2017 amount to approximately 1.5 million EUR" (Eurydice, 2018, pp. 30). This statement may be true for primary school teachers and teachers of some streams, but cannot be generalized to STEM teachers, especially teachers of Physics and Technics and Technology (hereafter TaT). But even if there was some surplus at the time of the report, signs of warning come from the OECD (2017), in which the Slovenian data is as follows:

- At the primary level, 6% of teachers are younger than 30; 63% are between 30 and 49, and 32% of teachers are older than 50. The average ratio for the OECD is 12–52–40.
- At the lower secondary level, 4% of teachers are younger than 30; 59% are between 30 and 49, while 37% are 50 or older. The average ratio for the OECD is 10–54–36.
- At the upper secondary level, 3% of teachers are younger than 30; 59% are between 30 and 49, and 38% are 50 or older. The average ratio for the OECD is 7–52–40.

Nor do the Eurydice data reflect data from the two faculties that educate future primary school STEM teachers in Slovenia: the Faculty of Education, University of Ljubljana and the Faculty of Natural Sciences and Mathematics, University of Maribor (Ploj Virtič et. al., 2017). These two faculties are responsible for educating more than 95% of all new teachers, and both have problems with enrolment of students in their prospective STEM teacher programmes.

General Background of Research

Slovenia's challenges in education are identical to those of most EU countries. The shortage, on the one hand, and the oversupply of teachers, on the other, may have different causes. At any rate, detailed planning of teacher education at the Slovenian national policy level could improve the situation.

The educational system in Slovenia has undergone some major structural changes over the last 20 years. These consist of structural changes in primary education in 2003, which extended it from eight to nine years, and the transformation of university study programs according to the Bologna reform in 2007 (Žužek Leskovšek, 2018). These changes raised the demand for new teachers at the primary level of education and caused the development of new study programs at university levels, all of which had an impact on the financial aspects of education. For this reason, the Slovenian government changed the Organization and Financing of Education Act (Organization and Financing of Education Act, 1996) in 2003, allowing teachers to teach subjects for which they do not have formal education up to 40% of their working time. This act was meant to be temporary and to help overcome the teacher shortage due to the structural changes. The act remained active until 2015, when the percentage was gradually lowered to 20% in 2017 and to 0% currently. The lowering of that percentage happened because of constant warnings by the professional public, organizations, and university educators. They raised the concern that this act was in violation of ILO/UNESCO guidelines (ILO/UNESCO, 1996) and the Act of Rules on the level of education of teachers and other professionals in the educational programs of primary schools (Rules on the level of education of teachers and other professionals in educational programmes of primary schools, 2011), as well.

During this time, the economic crisis began in Slovenia, which resulted in additional government fiscal restraint. Another huge impact on the educational system resulted from the Fiscal balancing act (Fiscal Balance Act, 2012). Teachers are public employees, and the Fiscal balancing act halted the employment of new teachers between 2012 and 2016. It also lowered teachers' salaries by approximately 8% until 2018 and had a devastating impact on the public image of teachers (Fiscal Balance Act, 2012). The lack of employment of new teachers meant that teachers were teaching more and more subjects in which they did not have formal education. We believe all these factors contributed to a significant drop in the enrolment of students at faculties that produce lower secondary STEM teachers.

The conflict between the misleading information about teacher oversupply and teacher shortage was investigated, and a solution was sought in detailed planning for at least STEM teachers, because this shortage affected the school system the most.

Research methods and procedures

The aim of the research was to gather data from public sources to build predictive models of the potential shortage of teachers in various subjects of STEM education in lower secondary schools, especially for TaT teachers. Data were obtained from the Statistical office of the Republic of Slovenia (SURS, 2019), the Ministry of Education, Science and Sport (Ministry of Education, Science and Sport, 2020), the Employment Service of Slovenia (Employment Service of Slovenia, 2020) and from two faculties: University of Ljubljana, Faculty of Education and the University of Maribor, Faculty of Natural Science and Mathematics.

Based on desk-top research, we assembled the research questions as follows:

- To what extent, if at all, does fluctuation in the numbers of 1st-grade pupils over time suggest that there will be a teacher shortage?
- To what extent, if at all, does the fluctuation in future teacher retirement in STEM and Technics and Technology (TaT) suggest that there will be a teacher shortage?
- To what extent, if at all, does the fluctuation in the number of new students in STEM pedagogical study programs over time suggest that there will be a teacher shortage?
- To what extent, if at all, does the fluctuation in the number of newly graduated STEM teachers over time suggest that there will be a teacher shortage?

Findings

Data acquired from the Statistical Office shows increased enrollment among first-grade pupils over time (Figure 1). The increase in the first-grade pupil population between 2011 and 2018 is almost 10%.

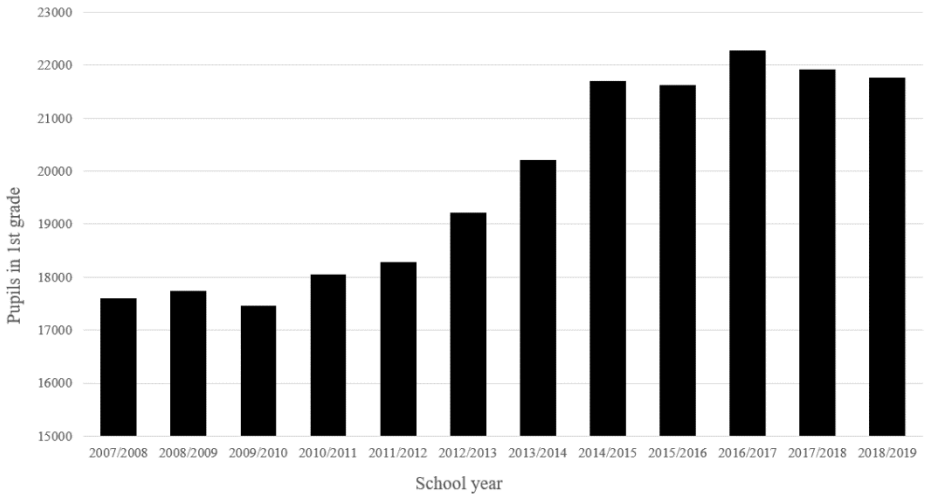

Figure 1: The fluctuation in the number of 1st-grade pupils over time (SURS, 2019)

From Figure 1, based on data from the Statistical Office of the Republic of Slovenia (SURS, 2019), it is possible to establish trends in the number of pupils enrolled in elementary school. The number of children in elementary education has been increasing since 2009/10, when the population of pupils was the lowest in independent Slovenia. The growth trend in the number of pupils enrolled in the first grade (see Figure 1) affects secondary schools and tertiary education after a time lag. Numerically, the smallest generation of first-graders in elementary school from 2009/10, appears as the smallest generation of first-graders in secondary schools in 2018/19, and the same generation of children will enter tertiary education in 2022/23. The numerically strong generations of children starting elementary school in 2014/15 (see Figure 1) will enter tertiary education in 2027/28.

The information on future teacher retirement in STEM fields (particularly TaT) can be used to explain concerns about the shortage. The data on teacher retirement received from the Ministry of Education, Science and Sport is shown in Figure 2. The data follow the retirement rules in Slovenia, which define the allowed retirement age as 60, with at least 40 years of service, and 65 for those with less than 40 years of service. The data shown in Figure 2 exclude teachers who teach STEM subjects in schools but lack formal education. To replace the retiring teacher population, at least the same number of students should be in master's studies before their retirement, an act of coordination that should be planned by the authorities.

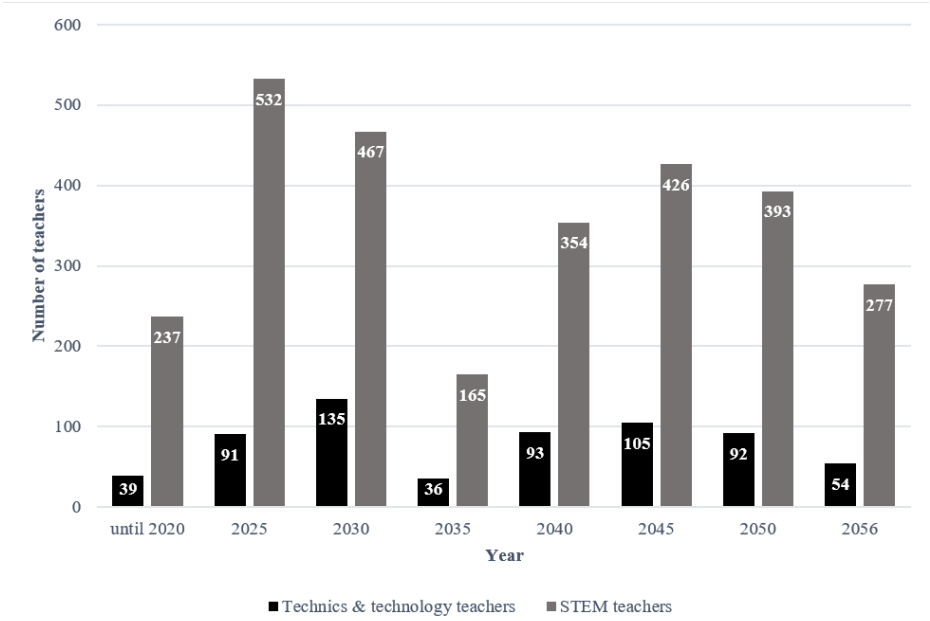

Figure 2: Projected teacher retirement over time

The number of all STEM teachers in lower secondary schools in Slovenia is 2206, and 645 of those have formal education in TaT and teach this subject. We can recognize two waves of retirement among STEM teachers from Figure 2. The first one has just begun and will peak in 2025; the second one will peak in 2045. The data is similar for TaT teachers, apart from the first peak, which will happen in 2030. Taking the retirements of 2020, 2025 and 2030 together, it is evident that there will be a total of 1236 STEM teachers retiring by 2030, of which 265 are teachers of TaT. These retirement numbers may not look high, but for a small country like Slovenia, this number represents 56% of all STEM teachers and 41% of TaT teachers in lower secondary schools in Slovenia.

As educators of pre-service STEM teachers, we have been observing a trend in the enrolment in programmes for prospective STEM teachers, which has fallen by 80% over the past 5 to 10 years. Data charting fluctuation in new student numbers in STEM pedagogical study programs over time shows a major drop in new students (Figure 3).

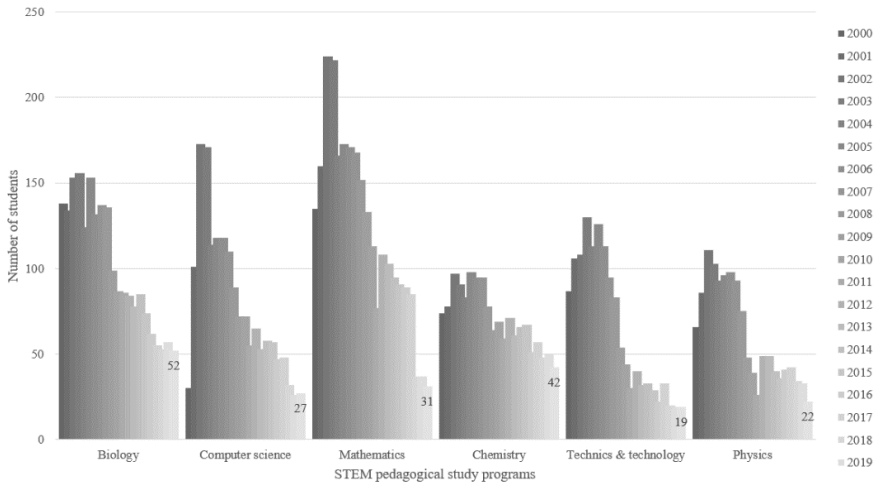

Figure 3: The fluctuation in the number of new students in STEM pedagogical study programs at both Universities over time

Figure 3 shows the fluctuation in the number of new students in STEM pedagogical study programs at both Universities that educate future elementary (mostly two-stream) school STEM teachers in Slovenia: the University of Ljubljana, and the University of Maribor. Data was extracted from their annual reports (unpublished data).

Data gathered from the University of Maribor, Faculty of Natural Sciences and Mathematics, show a drop of approximately 85% in the number of students in STEM pedagogical study programs. From an average of 220 new students around the year 2000, it has decreased to less than 30 students per year in 2019. Enrolment in the TaT pedagogical study program decreased from an average of 45 students around the year 2000 to only 3-5 students per year in 2019.

Data gathered from the University of Ljubljana's Faculty of Education show a less serious decrease. These data show a drop of approximately 40% in students in STEM pedagogical study programs. From an average of 250 new students in around 2000, the figure decreased to fewer than 150 students per year. Enrolment in the TaT pedagogical study program decreased from an average of 70 students around the year 2000, to 30 students per year in 2019.

Consequently, the fluctuation in newly graduated STEM teachers from both universities also shows a decreasing number of newly graduated STEM teachers, as shown in Figure 4.

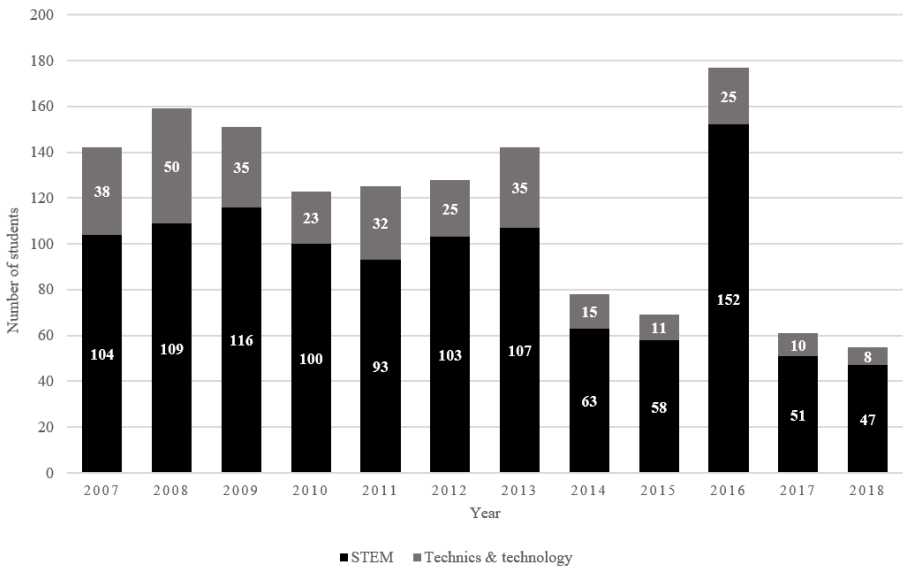

Figure 4: Newly graduated STEM (Technics & Technology, separately) teachers over the years

Because there are no restrictions or entrance exams for students enrolling in the first-year classes, and many of them recognize a teaching career as a secondary or even tertiary study choice (Tomažič, & Vidic, 2009), there is considerable drop-out during successive study semesters, which results in an even lower number of STEM teachers graduating from the program.

There was an increase in new STEM teacher graduates in 2016 because of the closure of the old pre-Bologna STEM study programs; many took this last chance to finish the programme. However, the additional number of 4-year Bachelor's degrees qualifying them to teach did not significantly improve teacher structure in the schools, because many of these graduates were already working in schools, while others had jobs outside the educational sector, and just wanted to finish their education and get a degree.

The greatest shortage is identified among teachers of TaT and Physics. Overall, 1236 STEM teachers (more than 50%) will retire between 2020 and 2030. The difference between the yearly supply of qualified teachers from universities and the retirement projection is presented in Figure 5.

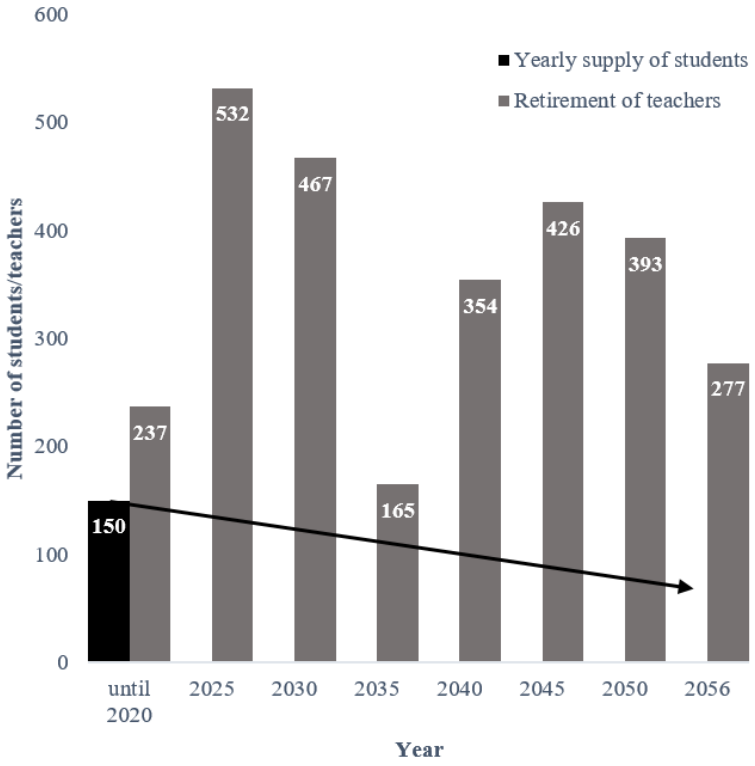

Figure 5: The difference between the annual supply of qualified STEM teachers from universities and the retirement projection

The trend line in Figure 5 shows the expected trend in annual supply, according to the current state of student enrolment if nothing is done to stop the trend. At first glance, the numbers are not high, but they are critical to the Slovenian situation. Moreover, because the official and obligatory language of teaching is Slovene, opportunities to import teachers are limited, and this means that the problem can only be solved by increasing the supply of STEM teachers from Slovenian universities to the employment market. It is only speculation that some teachers from the years of surplus and those recently employed in other economic sectors could be reactivated. Honestly said, we doubt that anyone would find the motivation to enter the educational sector after a career elsewhere.

Since the teacher is one of the key factors influencing the choice of further study (Šorgo et al., 2018) and the shortage of STEM teachers is evident, we can raise the following question: Will the shortage of STEM teachers in the long-term exert an impact on the technological development of Slovenia?

New rules of the game

At the beginning of 2020, there was an outbreak of COVID-19. At this moment we cannot predict the future; however, there exists a possibility that the number of students in each class will be limited if a new outbreak should occur. If this happens, the shortage of teachers in all subjects can only worsen and the problem become more extensive. We cannot make calculations based on the numbers we possess, but knowing the situation in the schools, the shortage could be severe

Discussion and Conclusions

From the data presented by the Ministry of Education, Science and Sport, it is evident that there will be a total of 1236 STEM teachers retiring by 2030, of which 265 are teachers of Technics and Technology (TaT). This number represents 56% of all STEM teachers and 41% of TaT teachers in lower secondary schools in Slovenia. There has been no unemployed STEM teacher registered at the Employment Service for several years. At the same time, the enrolment in programmes for prospective STEM teachers has fallen by 80% over the past 15 to 20 years. The data clearly predict a shortage of teachers, a situation worsened by the increasing number of school-age pupils, which is evident from the growth trend in the number of pupils enrolled in the first grade.

Based on the numbers presented in the Figures, we can predict that, without a change in educational policy towards encouraging students to choose the teaching of STEM subjects as a career, the number of STEM teachers will fall below all acceptable levels.

Recently, the greatest shortfall has been in the STEM field, especially in technical subjects and Physics, where schools already cannot employ teachers from these fields. With the decrease in students at both faculties that educate future STEM teachers, planning data for STEM subjects indicates that the need for STEM teachers is already greater than this year's supply.

The only solution that would maintain the quality of STEM education is an increase in the number of STEM students enrolled in pedagogical studies. The proposed solution needs serious government support and the incorporation of teacher education planning at the level of Slovenian national policy. Based on research (Feng & Sass, 2015) confirming that financial effects provide positive motivation for the decision to choose an area of study, it would also make sense to discuss scholarships for those studying towards occupations with a supply deficit, as was the case in good practice during the 1980s and 1990s.

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Declaration of Interest statement

The authors declare that they have no conflict of interest. The article is an original work of all the authors, and has not been submitted elsewhere, nor is it under consideration for publication in any other journal.

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REVIJA ZA ELEMENTARNO IZOBRAŽEVANJE
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PREGLED VREDNOTENJ NARAVOSLOVNEGA ZNANJA V PRVEM VZGOJNO-IZOBRAŽEVALNEM OBDOBJU OSNOVNE ŠOLE

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Abstract/Izvleček V prispevku je prikazan pregled vrednotenj naravoslovnega znanja slovenskih osnovnošolcev v prvem vzgojno-izobraževalnem obdobju. Ker tega na nacionalnem nivoju ne merimo kohortno, smo se osredinili predvsem na izsledke mednarodne raziskave TIMSS, ki ugotavlja matematično in naravoslovno znanje učencev iz različnih držav vsake štiri leta. Slovenija je bila v njej udeležena od leta 1995 do 2015, kar pomeni dragocen vir podatkov o znanju slovenskih osnovnošolcev. Po pregledu in analizi rezultatov preverjanj naravoslovnih znanj slovenskih četrtošolcev ugotavljamo, da se to v primerjavi z mednarodnim povprečjem vztrajno povečuje, hkrati pa njihov odnos do naravoslovja vztrajno zaostaja za mednarodnim povprečjem.

An overview of Science Knowledge Evaluation in the First Three Grades of Elementary School

This paper presents an overview of Slovenian elementary school evaluation of students' natural science knowledge in the first three years of elementary school. Science knowledge in Slovenia is not measured regularly; therefore, we have focused primarily on the results of the international TIMSS survey, which measures the mathematical and natural science knowledge of students. The TIMMS survey is performed every four years in various countries, and Slovenia participated from 1995 to 2015. After reviewing and analysing the results of the natural science examinations of Slovenian fourth-graders, we found a steady increase compared to the international average. However, at the same time, the positive attitude towards science lags behind.

Ključne besede:
vrednotenje znanja, naravoslovje, osnovnošolci, mednarodna raziskava TIMSS

Keywords:
knowledge evaluation, natural sciences, elementary school students, international TIMSS survey

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Uvod

Zaradi hitrega znanstvenega in tehnološkega razvoja mora posameznik za uspešno spopadanje z izzivi današnjega časa izkazovati določeno stopnjo naravoslovnega znanja oziroma pismenosti.

Današnje pojmovanje znanja sega daleč onkraj golega poznavanja in razumevanja dejstev in povezav. Učenje namreč danes opredeljujemo kot vsako pridobitev ali spremembo védenja, informiranosti, razumevanja, stališč, spretnosti, zmožnosti ali vedênja, z izkustvom, vajo, poučevanjem ali študijem (UNESCO-IUS, 2012). Naravoslovno znanje (ang. *scientific knowledge*) je v strokovni literaturi (Raper in Stinger, 1991, Harlen in Qualter, 2009) najpogosteje opredeljeno kot preplet posameznikovega naravoslovnega védenja (ang. *concepts*), spoznavnih procesov in postopkov (ang. *skills*) ter njegovih naravoslovnih stališč (ang. *attitudes*). Po Raper in Stinger (1991) naravoslovno védenje tvorijo dejstva (poimenovanja, definicije, dogovori), koncepti (splošne zamisli, načela, znanstveni zakoni in teorije) in razumevanje. Harlen in Qualter (2009) spoznavne procese in postopke delita na raziskovalne, miselne, učne in sporočevalne. Pri tem omenjata predvsem zastavljanje vprašanj, napovedovanje, načrtovanje in zbiranje podatkov, analiziranje in interpretacijo podatkov, sporočanje, oblikovanje zaključkov, razvrščanje, urejanje, primerjanje, prepoznavo vzorcev, reševanje problemov in povzemanje. Glede naravoslovnih stališč je med avtorji največ razhajanj; mi se bomo oprli na členitev na odnos do naravoslovja (ang. *attitudes towards science*) in naravoslovne vrednote (ang. *scientific attitudes*), kot jo navaja Gardner (2008). Odnos do naravoslovja zajema zanimanje za naravoslovje, naravnanost do naravoslovja, družbeno odgovornost na področju naravoslovja ipd.; naravoslovne vrednote pa radovednost, dojemljivost, intelektualno poštenost, preudarnost, skepso ipd. Sistematično učenje naravoslovnih vsebin se v Sloveniji začne v vrtcu in nadaljuje v prvem vzgojno-izobraževalnem obdobju v okviru predmeta spoznavanje okolja. Iz veljavnega kurikuluma za vrtce (Bahovec in drugi, 1999) in učnega načrta za predmet spoznavanje okolja (Kolar in drugi, 2011) je razvidno, da oba dokumenta zajemata vsa tri področja naravoslovnega znanja (védenje, spoznavni procesi in postopki ter stališča) in z didaktičnimi priporočili spodbujata vzgojitelje oziroma učitelje k uporabi raznolikih metod poučevanja. Prav tako oba dokumenta svetujeta uporabo socialno konstruktivističnega pristopa, ki temelji na otrokovi aktivni udeležbi pri gradnji lastnega znanja.

Pri učnem predmetu spoznavanje okolja v prvem vzgojno-izobraževalnem obdobju se gradi temelje naravoslovne pismenosti. Zaradi tega ima lahko neustrezno poučevanje naravoslovnih vsebin v tem obdobju daljnosežne posledice za naravoslovno pismenost posameznika in celotno družbo. Zato je izjemno pomembno, da sistematično preverjamo naravoslovno znanje učencev med prvim vzgojno-izobraževalnim obdobjem in po njem ter ugotavljamo pogoje, v katerih je omenjeno znanje pridobljeno. Odgovor na to vprašanje lahko dobimo le z ustreznimi nacionalnimi in mednarodnimi raziskavami. V Sloveniji v zadnjih desetletjih ni bilo izvedene večje nacionalne raziskave v povezavi z naravoslovnim znanjem v prvem vzgojno-izobraževalnem obdobju, smo pa v letih od 1995 do 2015 sodelovali v mednarodni raziskavi TIMSS (ang. *Trends in International Mathematics and Science Study*), ki jo izvaja mednarodna organizacija za ugotavljanje učinkov izobraževanja (ang. International Association for the *Evaluation* of Educational Achievement – IEA). V omenjeni raziskavi se med drugim preverja tudi naravoslovno znanje četrtošolcev in pogoje, v katerih je bilo pridobljeno. Podatki, pridobljeni v raziskavi TIMSS, so javno dostopni, kar omogoča izvedbo različnih analiz in sekundarnih raziskav.

Vrednotenje naravoslovnega znanja v Sloveniji

V Sloveniji na državni ravni ne izvajamo širših raziskav naravoslovnega znanja. Ugotavljenje in vrednotenje naravoslovnega znanja v prvem vzgojno-izobraževalnem obdobju je bilo v zadnjih letih opravljeno v le dveh raziskavah, ki sta ju izvedla Petek (2005) ter Petek in Glažar (2015). Še nekaj slovenskih raziskovalcev (Bajd in Artač, 1995; Ivanuš Grmek in drugi, 2009; Rajšp in drugi, 2013; Cotič in drugi, 2019) se je v svojih raziskavah dotaknilo naravoslovnega znanja osnovnošolcev, vendar so izsledki teh raziskav uporabni le posredno in v manjšem obsegu, saj njihov osnovni cilj ni bilo merjenje naravoslovnega znanja, temveč ugotavljanje vpliva izbranih učnih metod in pristopov na doseganje določenih segmentov znanja. Raziskovalci s Pedagoškega inštituta so 20 let sodelovali v mednarodni raziskavi TIMSS (Martin in drugi, 1997, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016). Slovenija se je namreč udeležila vseh izvedb omenjene raziskave, od prve izvedbe v letu 1995 do šeste v letu 2015.

Preden si podrobneje ogledamo rezultate posameznih raziskav, je treba izpostaviti, da je, kot poudarja Štraus (2006), prednost nacionalnih raziskav prilagojenost specifičnim okoliščinam v državi, prednost mednarodnih raziskav pa je primerljivost podatkov z drugimi državami.

Nacionalne raziskave naravoslovnega znanja

Kot smo že omenili, sta bili v povezavi z ugotavljanjem in vrednotenjem naravoslovnega znanja učencev prvega vzgojno-izobraževalnega obdobja v Sloveniji v zadnjih letih izvedeni le dve raziskavi. Prvo je ob uvajanju devetletnega programa osnovne šole izvedla Petek (2005). Zanimalo jo je, ali se je ob uvedbi novega osnovnošolskega programa in s tem povezanimi novimi metodami dela znanje sedemletnikov izboljšalo. Za merjenje znanja je uporabila standardiziran preizkus znanja *Science Assesement Series 1*, razvit na Univerzi v Liverpoolu. Ker se je novi osnovnošolski program uvajal postopno in sta nekaj časa vzporedno potekala novi in stari osnovnošolski program, je lahko sočasno ugotavljala znanje, pridobljeno v okviru obeh programov. Raziskava je pokazala, da sedemletniki, vključeni v devetletni program osnovne šole, v primerjavi z vrstniki v osemletnem programu osnovne šole, pri reševanju različnih tipov nalog izkazujejo boljše rezultate na ravni procesnih znanj in dosegajo višje kognitivne stopnje. Omenjena avtorica je skupaj s sodelavcem (Petek in Glažar, 2015) deset let kasneje izvedla podobno raziskavo z istim instrumentom, s katero je ugotavljala, ali se je na področju naravoslovja v prvem vzgojno-izobraževalnem obdobju tedaj že devetletnega programa osnovne šole zgodil premik od spominskega znanja k znanju z razumevanjem, kot je to nakazala prejšnja raziskava. Rezultati raziskave so pokazali, da je naravoslovno znanje učencev, starih od 7 do 9 let, na določenih področjih še vedno pomanjkljivo, še posebej to velja za sposobnosti sporočanja, napovedovanja in sklepanja ter zbiranja in urejanja informacij. Raziskavo s področja zgodnjega poučevanja naravoslovja, ki se dotika tudi ugotavljanja naravoslovnega znanja v prvem vzgojno-izobraževalnem obdobju, je izvedla Ivanuš Grmek s sodelavci (2009). Ugotavljali so vpliv različnih didaktičnih pristopov pri poučevanju predmeta spoznavanje okolja v tretjem razredu osnovne šole na znanje učencev in njihov interes za spoznavanje naravoslovnih in družboslovnih vsebin.

Pred izvedbo didaktičnega eksperimenta in po njem je raziskovalna skupina preverila znanje učencev iz vsebin učnega predmeta spoznavanje okolja. Izkazalo se je, da sta učenčevo razumevanje in uporaba učne snovi boljša, kadar so vsebine podane z didaktičnimi pristopi, ki po Strmčniku (2003) tvorijo odprti pouk.

Mednarodna raziskava TIMSS

Pri ugotavljanju naravoslovnega znanja slovenskih učencev po prvem vzgojno-izobraževalnem obdobju so nam v največjo pomoč izsledki mednarodne raziskave TIMSS (ang. *Trends in International Mathematics and Science Study*). Ta je namenjena ugotavljanju in primerjanju matematičnega in naravoslovnega znanja učencev iz različnih držav z vseh delov sveta ter pogojev, v katerih je to znanje pridobljeno. Raziskava se pod okriljem Mednarodne organizacije za ugotavljanje učinkov izobraževanja (IEA) izvaja vsaka štiri leta. V osnovni izvedbi raziskave sodelujejo učenci 4. in 8. razredov, in sicer skupno najmanj 4000 učencev iz vsake sodelujoče države. Raziskava TIMSS poleg merjenja znanja učencev s preizkusi znanja zajema tudi ugotavljanje njihovih stališč in občutij z anketnimi vprašalniki. V raziskavi sodelujejo tudi njihovi starši in učitelji ter ravnatelji šol, katerih učenci so udeleženi v raziskavi. S tem so pridobljeni tudi podatki o dejavnikih, ki vplivajo na pridobivanje in izkazovanje znanja.

Slovenija je v raziskavi TIMSS sodelovala vse od njenega začetka v letu 1995. S tem je bila pridobljena tudi zelo pomembna možnost primerjave izsledkov posameznih izvedb raziskave in ugotavljanja trendov. Z odločitvijo Ministrstva za izobraževanje, znanost in šport, da Slovenija v raziskavi TIMSS 2019 ne bo sodelovala, smo to možnost v prihodnosti izgubili. V tolažbo je lahko zagotovilo omenjenega Ministrstva, da bo zagotovilo sredstva za izvedbo večje sekundarne analize podatkov dosedanjih raziskav TIMSS.

Osnovni cilj raziskave TIMSS je pomoč udeleženim državam pri sprejemanju odločitev, povezanih s poučevanjem matematike in naravoslovja na osnovnošolski in srednješolski ravni. Ena od pomembnih možnosti uporabe podatkov raziskave TIMSS je raziskovanje vpliva različnih dejavnikov v izobraževalnem sistemu na njegovo uspešnost v sekundarnih raziskavah.

Kljub metodološko dobri zasnovi in zanesljivi izpeljavi raziskave TIMSS velja opozoriti, da je prenašanje ugotovitev na nacionalno raven in primerjanje posameznih držav precej zahtevno.

Markelj in Majerič (2009) opozarjata na previdnost pri uporabi rezultatov mednarodnih raziskav in poudarjata, da je treba rezultate interpretirati v okviru zastavljenega koncepta šolskega sistema. K temu dodajamo še širši kulturno in družbeni okvir. Na previdnost pri interpretaciji rezultatov raziskave TIMSS opozarjajo nizozemski raziskovalci (Knuver, 1999), ki so natančno analizirali pilotne preizkuse znanja raziskave v letu 1995. Ugotovili so, da je le približno polovica nalog po vsebini primerna za starostno stopnjo, ki ji je namenjena. Kritični so tudi do velikega številu nalog, ki zahtevajo dobre bralne zmožnosti in visoko stopnjo bralnega razumevanja ter do nalog s tehničnimi pomanjkljivostmi (moteči ali manjkajoči elementi). Ob tem ne smemo pozabiti, da se ugotovitve nanašajo na prvo izvedbo raziskave.

Naravoslovno znanje slovenskih učencev v raziskavi TIMSS

V nadaljevanju si bomo ogledali podatke, pridobljene v povezavi z naravoslovnim znanjem slovenskih četrtošolcev v vseh dosedanjih izvedbah mednarodne raziskave TIMSS, s poudarkom na izvedbi leta 2015 – zadnji izvedbi, pri kateri je sodelovala Slovenija. Ob tem je treba poudariti, da je bila raziskava TIMSS leta 1999 izvedena le med osmošolci, zato jo v naši analizi, ki s nanaša na naravoslovno znanje v prvem vzgojno-izobraževalnem obdobju, izpuščamo. Opozoriti je treba tudi na raziskavo leta 1995, ki je bila z enakim preizkusom znanja izvedena na tretješolcih in četrtošolcih. V tej raziskavi so bili tako naši tretješolci kot četrtošolci (takrat še osemletne osnovne šole) v povprečju skoraj leto dni starejši od tretješolcev oziroma četrtošolcev iz drugi držav, zato sta bila oba naša vzorca označena kot starostno neustrezna. Ker so bili naši tretješolci po starosti bližje četrtošolcem iz drugih držav, v naši analizi raziskave iz leta 1995 primerjamo dosežke naših tretješolcev z dosežki četrtošolcev iz drugih držav.

Splošen dosežek slovenskih četrtošolcev leta 2015

Rezultati mednarodnih raziskav znanja so najpogosteje predstavljeni v obliki t. i. ranžirnih lestvic, v katerih so sodelujoče države razvrščene po povprečnih dosežkih učencev. Markelj in Majerič (2009) opozarjata, da je to le okvirna informacija o kakovosti šolskega sistema, ki ne zajema analize vpliva različnih dejavnikov na dosežene rezultate. V javnosti se izsledke mednarodnih raziskav pogosto interpretira površno – z navajanjem uvrstitev na ranžirnih lestvicah brez upoštevanja omenjenih dejavnikov.

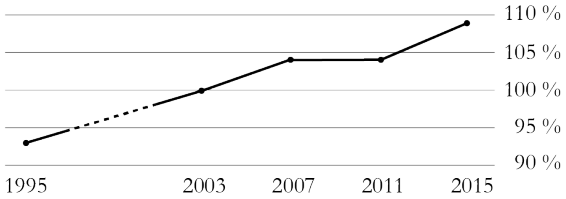
V raziskavi TIMMS 2015 so naši četrtošolci v povprečju izkazali znanje naravoslovja, ki je nad mednarodnim povprečjem vseh držav udeleženk – s 543 točkami so se uvrstili na 11. mesto med 47 sodelujočimi državami (Tabela 1). Povprečni dosežek slovenskih četrtošolcev v znanju naravoslovja v raziskavi TIMSS 2015 je po mnenju slovenskih izvajalcev raziskave zelo dober, saj za 43 točk presega mednarodno povprečje (lestvica je oblikovana tako, da 500 točk predstavlja povprečje dosežkov vseh sodelujočih držav). Kot lahko razberemo iz preglednice 1, so se pred Slovenijo uvrstile najbolj razvite azijske države (Singapur, Južna Koreja, Japonska, Hong Kong in Tajvan) ter Kazahstan, Finska, Poljska in ZDA. Povprečni dosežki četrtošolcev iz navedenih držav, z izjemo Singapurja in Južne Koreje, ne presegajo povprečnega dosežka slovenskih četrtošolcev za več kot 5 % (Japelj Pavešič in Svetlik 2016). Povprečne dosežke četrtošolcev, ki so podobni (± 2 %) povprečnemu dosežku slovenskih četrtošolcev, beležijo Finska (554), Kazahstan (550), Poljska (547), ZDA (546), Madžarska (542), Švedska (540), Norveška (538), Anglija (536), Bolgarija (536), Češka (534) in Hrvaška (533). Poleg povprečnih dosežkov četrtošolcev posameznih držav (500 točk je mednarodno povprečje, 100 točk je standardni odklon) so prikazana še razmerja povprečnih dosežkov četrtošolcev izbranih držav in mednarodnega povprečja ter razmerja povprečnih dosežkov četrtošolcev izbranih države in povprečnega dosežka slovenskih četrtošolcev. (Vir: Japelj Pavešič in Svetlik, 2016).

Tabela 1: Primerjava najvišjih povprečnih dosežkov četrtošolcev posameznih držav v znanju naravoslovja v raziskavi TIMSS 2015 s povprečnim dosežkom slovenskih četrtošolcev.

Država	Povprečni dosežek četrtošolcev	Razmerje med povprečnim dosežkom izbrane države	
		in mednarodnim povprečjem	in slovenskim povprečnim dosežkom
Singapur	590	118 %	109 %
Južna Koreja	589	118 %	109 %
Japonska	569	114 %	105 %
Ruska federacija	567	113 %	104 %
Hong Kong	557	111 %	103 %
Tajvan	555	111 %	102 %
Finska	554	111 %	102 %
Kazahstan	550	110 %	101 %
Poljska	547	109 %	101 %
ZDA	546	109 %	101 %
Slovenija	543	109 %	—

Splošen naravoslovni dosežek slovenskih četrtošolcev od leta 1995 do 2015

Če primerjamo povprečne dosežke slovenskih četrtošolcev v znanju naravoslovja v vseh dosedanjih izvedbah raziskave TIMSS (slika 1), opazimo, da v preteklih izvedbah naši učenci niso bili tako uspešni kot leta 2015. Hkrati opazimo stalen pozitivni trend, pri čemer je treba poudariti, da je statistično nepomembno le napredovanje med letoma 2007 in 2011. Na grafičnem prikazu (slika 1) sta opazni dve večji spremembi povprečnega dosežka, in sicer med letoma 1995 in 2003 ter letoma 2011 in 2015. Prvo povečanje sovpada z uvedbo devetletnega programa osnovne šole, drugo pa s prenovo učnih načrtov v osnovni šoli.



Leto raziskave	Povprečni dosežek slovenskih četrtošolcev	Mednarodno povprečje četrtošolcev	Razmerje med slovenskim povprečnim dosežkom in mednarodnim povprečjem
1995	487 (464)	524	93 %
2003	490 (501)	489	100 %
2007	518	500	104 %
2011	520	500	104 %
2015	543	500	109 %

Slika 1: Prikaz povprečnih dosežkov slovenskih četrtošolcev (v letu 1995 tretješolcev) na področju naravoslovja vseh dosedanjih izvedb raziskave TIMSS v primerjavi z mednarodnim povprečjem. Pri raziskavah v letu 1995 in 2003 so v preglednici v oklepajih prikazane vrednosti, ki ustrezajo dosežku, če bi mednarodno povprečje tudi tisto leto znašalo 500 točk. (Vir: Martin in drugi, 1997, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016.)

V naravoslovnih dosežkih so naši četrtošolci v dvajsetih letih (od leta 1995 do 2015) v povprečju napredovali za 78 točk, kar predstavlja približno šestino povprečnega dosežka TIMSS. Na podlagi dosedanjih rezultatov raziskave TIMSS lahko trdimo, da naravoslovno znanje različnih generacij četrtošolcev glede na mednarodno povprečje ves čas narašča.

Iz tega lahko sklepamo, da se zgodnje poučevanje naravoslovja pri nas primerjalno glede na druge države udeleženke raziskave TIMSS izboljšuje.

Vse do sedaj predstavljene primerjave dosežkov naših četrtošolcev se nanašajo na mednarodno povprečje (tj. povprečni dosežek učencev vseh držav, udeleženih v posamezni raziskavi). Ob tem se je treba zavedati, da so v vsaki izvedbi raziskave TIMSS sodelovale tudi države, ki se po ekonomskih, političnih, kulturnih in drugih kriterijih močno razlikujejo od Slovenije. Omenjene države so se na ranžirnih lestvicah večinoma uvrščale pod vsakokratno mednarodno povprečje in ga s svojim povprečnim dosežkom nižale. Zato je smiselno primerjati povprečne dosežke naših učencev z učenci iz ekonomsko in kulturno primerljivih držav. V ta namen smo za vsako izvedbo raziskave TIMSS oblikovali tri skupine držav udeleženk glede na njihov trenutni ekonomski oziroma politični status, in sicer: (1) udeleženke, ki veljajo za visoko razvite države (po definiciji Mednarodnega monetarnega sklada so to države z vrednostjo indeksa človekovega razvoja 0,8 ali več); (2) udeleženke, ki so članice Evropske unije, in (3) udeleženke, ki so članice Organizacije za gospodarsko sodelovanje in razvoj.

Iz tabele 2 je razvidno, da se v teh primerjavah naši učenci slabše odrežejo, saj so povprečni dosežki izbranih treh skupin držav za okoli 5 % višji od mednarodnega povprečja. Kot lahko vidimo, so povprečni dosežki naših četrtošolcev, z izjemo leta 2015, pod povprečnimi dosežki omenjenih skupin držav.

Tabela 2: Prikaz povprečnih dosežkov slovenskih četrtošolcev na področju naravoslovja v vseh dosedanjih izvedbah raziskave TIMSS v primerjavi s povprečnimi dosežki njihovih vrstnikov iz izbranih skupin držav. Za leto 1995 rezultati niso prikazani, ker vzorci učencev iz nekaterih držav (tudi Slovenije) niso ustrezali merilom, zaradi česar so primerjave med državami slabo osnovane. (Vir: Martin in drugi, 1997, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016.)

Leto raziskave	Povprečni dosežek slovenskih četrtošolcev	Povprečni dosežek četrtošolcev		
		visoko razvitih držav	držav članic EU	držav članic OECD
2003	490	489	521	520
2007	518	500	532	525
2011	520	500	516	524
2015	543	500	516	525

Razlike v dosežkih istih generacij v 4. in 8. razredu

Mednarodna raziskava TIMSS zaradi štiriletnega cikla in hkratnega testiranja četrtošolcev in osmošolcev omogoča ugotavljanje spreminjanja znanja naravoslovja z leti šolanja znotraj posamezne generacije. Če namreč primerjamo povprečne naravoslovne dosežke četrtošolcev posamezne izvedbe raziskave TIMSS učencev s povprečnimi dosežki osmošolcev v naslednji izvedbi raziskave TIMSS (preglednica 3), izvemo, koliko se je v štirih letih spremenilo naravoslovno znanje iste generacije otrok.

Tabela 3: Prikaz povprečnih dosežkov naših četrtošolcev v znanju naravoslovja v raziskavah TIMSS 2003, 2007 in 2011 in povprečnih dosežkov naših osmošolcev v znanju naravoslovja v pripadajočih štiri leta kasnejših izvedbah raziskave TIMSS (2007, 2011 in 2015). Pri raziskavi v letu 2003 je za lažjo primerjavo z raziskavami v kasnejših letih v oklepaju prikazana vrednost, ki ustreza dosežku, če bi mednarodno povprečje tudi tisto leto znašalo 500 točk. (Vir: Martin in drugi, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016.)

Leto raziskave	Povprečni dosežek slovenskih četrtošolcev
2003	490 (501)
2007	518
2011	520

Leto raziskave	Povprečni dosežek slovenskih osmošolcev	Razlika med povprečnima dosežkoma osmošolcev in četrtošolcev
2007	538	+ 37
2011	543	+ 25
2015	551	+ 31

Iz tabele 3 je razvidno, da se je povprečni dosežek osmošolcev v znanju naravoslovja v primerjavi z njihovim dosežkom, ko so bili četrtošolci, v vseh prikazanih primerih (2003 → 2007, 2007 → 2011 in 2011 → 2015) izboljšal. Zadnji podatek kaže, da so učenci, ki so v raziskavi TIMSS 2011 kot četrtošolci pri naravoslovju v povprečju dosegli 20 točk nad mednarodnim povprečjem, v raziskavi TIMSS 2015 kot osmošolci v povprečju dosegli 51 točk nad mednarodnim povprečjem. To pomeni, da se je od četrtega do osmega razreda odstopanje povprečnega dosežka slovenskih učencev od mednarodnega povprečja več kot podvojilo. Znanje naravoslovja naših četrtošolcev v letu 2011 je bilo v povprečju za 4 % višje od mednarodnega povprečja, znanje iste generacije učencev čez štiri leta, ko so bili osmošolci, pa je bilo v povprečju za 10 % višje od mednarodnega povprečja.

Pregled dosežkov slovenskih četrtošolcev glede na mednarodne mejnike znanja

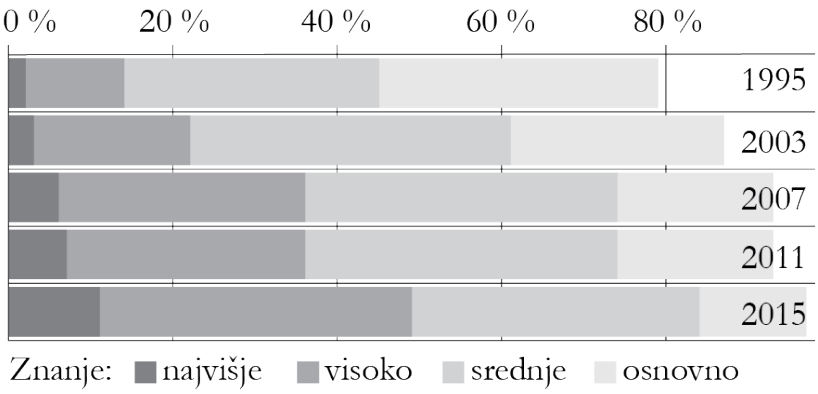
Podrobnejša analiza dosežkov slovenskih četrtošolcev v znanju naravoslovja v raziskavi TIMSS 2015 je pokazala, da je znanje znotraj države precej homogeno. To se ujema z osnovno usmeritvijo našega šolskega sistema, ki naj bi vsem omogočal enake možnosti.

V raziskavi TIMSS so opredeljeni štirje mejniki znanja: 400 točk predstavlja mejnik osnovnega znanja, 474 točk mejnik srednjega znanja, 500 točk mejnik visokega znanja in 625 točk mejnik najvišjega znanja. V skladu z omenjenimi mejniki lahko znanje posameznega učenca glede na njegov dosežek opredelimo kot:

- osnovno zanje (400–473 točk): učenec pokaže osnovno znanje o živi in neživi naravi;
- srednje znanje (474–549 točk): učenec ima osnovno znanje in razumevanje naravoslovja (žive narave, nežive narave in ved o Zemlji);
- visoko znanje (550–624 točk): učenec uporablja znanje in razumevanje za razlago vsakdanjih in abstraktnih pojavov;
- najvišje znanje (625 in več točk): učenec pozna in razume naravoslovne procese in pokaže znanje o postopkih znanstvenega raziskovanja.

Slovenija je po deležu učencev, ki so v raziskavi TIMSS 2015 izkazali najvišje naravoslovno znanje (teh je 11 %), na 14. mestu med 47 sodelujočimi državami (slika 2). V deležih učencev, ki so dosegli druge mejnike znanja, je Slovenija zelo podobna Nemčiji in Švedski. Podatek, da v raziskavi TIMSS 2015 skoraj vsi učenci izkazujejo vsaj osnovno znanje, je že sam po sebi razveseljiv. Podobno lahko trdimo tudi za dejstvo, da skoraj polovica slovenskih četrtošolcev dosega visoko raven znanja (več kot 110 % mednarodnega povprečja).

Primerjava povprečnih dosežkov slovenskih četrtošolcev v različnih izvedbah raziskave TIMSS je pokazala, da se je, odkar sodelujemo v raziskavi (z izjemo 2007 → 2011), ves čas povečeval delež učencev, ki so dosegali višje stopnje naravoslovnega znanja. Delež učencev, ki so dosegli visoko znanje, se je v 20 letih več kot potrojil in je leta 2015 dosegal skoraj polovico populacije. Delež učencev s srednjim znanjem se je s 45 % povečal na 84 % učencev in delež učencev z osnovnim znanjem se je z 79 % dvignil na 97 %. Glede na povečevanja deleža učencev, ki dosegajo višje stopnje znanja, lahko sklepamo, da se v slovenskih šolah pri pouku naravoslovnih vsebin v prvem vzgojno-izobraževalnem obdobju diferenciacija ustrezno izvaj



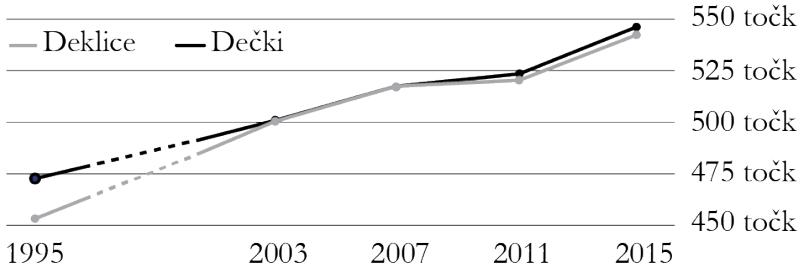
Leto raziskave	Osnovno znanje	Srednje znanje	Visoko znanje	Najvišje znanje
1995	79 %	45 %	14 %	2 %
2003	87 %	61 %	22 %	3 %
2007	93 %	74 %	36 %	6 %
2011	93 %	74 %	36 %	7 %
2015	97 %	84 %	49 %	11 %

Slika 2: Prikaz doseganja mednarodnih mejnikov znanja slovenskih četrtošolcev (za leto 1995 tretješolcev) na področju naravoslovja v vseh dosedanjih izvedbah raziskave TIMSS. (Vir: Martin in drugi, 1997, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016.)

Pregled dosežkov slovenskih četrtošolcev po spolu

Podatki raziskave TIMSS omogočajo tudi primerjavo dosežkov po spolu. Glede na že predstavljeno naraščanje povprečnih dosežkov v znanju celotne populacije ni presenetljivo, da se tako pri deklicah kot pri dečkih kaže stalen napredek v znanju. Naraščanja povprečnega dosežka znanja dečkov in deklic ne poteka enako (slika 3), saj se od raziskave do raziskave nekoliko spreminja razlika med povprečnima dosežkoma obeh spolov (Martin in drugi, 1997, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016). Razlika sicer ni velika (v letih 2003 in 2007 je bila razlika statistično nepomembna), niso pa slovenske deklice v povprečju nikoli izkazovale višjega znanja kot slovenski dečki.

Glede na majhne razlike v povprečnem dosežku naših četrtošolcev in četrtošolk lahko sklepamo, da pri nas pouk naravoslovnih vsebin v prvem vzgojno-izobraževalnem ni bolj naklonjen nobenemu spolu. Za primerjavo lahko navedemo, da v raziskavi TIMSS 2015 v 25 državah (od 47 držav, ki so sodelovale v raziskavi) niso izmerili statistično pomembnih razlik; v 11 državah so se bolje odrezali dečki, v prav toliko državah pa deklice.



Leto raziskave	Povprečni dosežek dečkov	Povprečni dosežek deklic	Razlika obeh dosežkov
1995	496 (473)	478 (456)	4 %
2003	491 (502)	490 (501)	0 %
2007	518	518	0 %
2011	523	517	1 %
2015	546	539	1 %

Slika 3: Prikaz povprečnih dosežkov slovenskih četrtošolcev in četrtošolk (za leto 1995 tretješolcev in tretješolk) na področju naravoslovja v vseh dosedanjih izvedbah raziskave TIMSS. Za leti 1995 in 2003 so v preglednici v oklepajih prikazane vrednosti, ki ustrezajo dosežku, če bi mednarodno povprečje tudi tisto leto znašalo 500 točk. (Vir: Martin in drugi, 1997, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016.)

Pregled dosežkov naših četrtošolcev po vsebinskih področjih

Vsebine v raziskavi TIMSS so razdeljene na tri vsebinska področja (tabela 4): živa narava, neživa narava in vede o Zemlji. Vsa tri področja niso enako zastopana: za reševanje nalog v povezavi z živo naravo je bilo predvideno, da bodo učenci porabili 45 % celotnega časa, za reševanje nalog s področja nežive narava 35 % časa in za reševanje nalog s področja ved o Zemlji 25 % časa.

Pri izbiri ciljev se je posebej pazilo, da bi bili ti kljub velikim razlikam med učnimi načrti naravoslovja v posameznih državah čim bolj univerzalni in vsaj posredno zajeti v učnih načrtih večine sodelujočih držav. Če primerjamo vsebinske sklope, zajete v raziskavi TIMSS 2015 (Japelj Pavešič in Svetlik, 2016), z vsebinami v našem učnem načrtu za predmet spoznavanje okolja (Kolar in drugi, 2011), opazimo, da vsebin, povezanimi z oblikami in prenosom energije, z zgradbo Zemlje, njenimi fizikalnimi lastnostmi in viri ter z zemeljskimi procesi in zemeljsko zgodovino v našem učnem načrtu za učni predmet spoznavanje okolja ni.

Tabela 4: Prikaz vsebinskih sklopov znotraj posameznih vsebinskih področij, ki so bili zajeti v testih znanja v raziskavi TIMSS 2015. (Vir: Japelj Pavešič in Svetlik, 2016.)

Živa narava	Neživa narava	Vede o Zemlji
- značilnosti in življenjski procesi organizmov življenjski cikli, razmnoževanje in dednost - organizmi, okolje in njihova interakcija - ekosistemi - zdravje človeka	- delitev in lastnosti ter spremembe snovi - oblike energije in prenos energije - sile in gibanje	- zgradba Zemlje, njene fizikalne lastnosti in viri - zemeljski procesi in zgodovina - Zemlja v sončnem sistemu

Podrobnejša primerjava ujemanja vsebin v preizkusu naravoslovnega znanja četrtošolcev v raziskavi TIMSS 2015 in vsebin v učnih načrtih posameznih držav pokaže, da je mednarodno povprečje ujemanja vsebin 65 %, medtem ko za Slovenijo ta vrednost znaša 68 %. Za vsebine s področja žive narave je mednarodno povprečje ujemanja vsebin 72 % (Slovenija 65 %), za neživo naravo 59 % (Slovenija 76 %) in za vede o Zemlji 66 % (Slovenija 63 %).

Kot lahko razberemo iz tabele 5, v raziskavi TIMMS 2015 pri vsebinah o živi in neživi naravi povprečni dosežek naših četrtošolcev za 2 oziroma 4 točke presega skupni povprečni dosežek, pri vsebinah o vedah o Zemlji pa za 12 točk zaostaja za njim. Višji dosežki pri neživi naravi in nižji dosežki pri vedah o Zemlji so skladni s stopnjo ujemanja vsebin, ki se preverjajo v okviru raziskave TIMSS z vsebinami, ki so zajete v našem učnem načrtu (Kolar in drugi, 2011).

Tabela 5: Prikaz povprečnih dosežkov slovenskih četrtošolcev na področju naravoslovja glede na vsebinska področja (za leto 1995 podatki niso prikazani, ker so se takrat vsebine delile na štiri vsebinska področja). Pri raziskavi v letu 2003 so v preglednici v oklepajih prikazane vrednosti, ki ustrezajo dosežku, če bi mednarodno povprečje tudi v tistem letu znašalo 500 točk. (Vir: Martin in drugi, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016.)

Leto raziskave	Skupni povprečni dosežek	Živa narava		Neživa narava		Vede o Zemlji	
		Povprečni dosežek pri tej vsebini	Razlika glede na celotni dosežek	Povprečni dosežek pri tej vsebini	Razlika glede na celotni dosežek	Povprečni dosežek pri tej vsebini	Razlika glede na celotni dosežek
995	490 (501)	489 (500)	– 1(– 1)	497 (508)	+ 7 (+ 8)	490 (501)	0
2003	518	511	– 7	530	+ 12	517	– 1
2007	520	524	+ 4	524	+ 4	506	– 14
2011	543	545	+ 2	546	+ 4	531	– 12
2015	490 (501)	489 (500)	– 1(– 1)	497 (508)	+ 7 (+ 8)	490 (501)	0

Trend naraščanja povprečnih dosežkov slovenskih učencev po uvedbi prenovljenih učnih načrtov je na vseh vsebinskih področjih podoben, povprečni dosežek na vsebinskem področju živa narava je v obdobju od leta 2011 do 2015 namreč narasel za 21 točk, na vsebinskem področju neživa narava za 22 točk in na vsebinskem področju vede o Zemlji za 25 točk. Omenjeni podatki sicer kažejo na zmanjševanje zaostanka na vsebinskem področju ved o Zemlji, kar je dobro, vendar zaostanek kljub vsemu ostaja znaten. Načeloma ni tehtnega razloga, da bi nacionalne učne načrte za posamezne predmete prilagajati vsebinam, ki se preverjajo v okviru mednarodnih raziskav, vendar bi se bilo v primeru učnega načrta za učni predmet spoznavanje okolje smiselno vprašati, ali ne bi vsebine, povezane z zgodovino in zgradbo Zemlje, sodile vanj. Ne zaradi raziskave TIMSS, temveč zaradi dejstva, da so omenjene teme uvrščene v učne načrte naravoslovja v mnogih razvitih državah.

Pregled dosežkov slovenskih četrtošolcev po kognitivnih področjih

Pri nalogah, ki zahtevajo poznavanje dejstev in postopkov ter uporabo znanja, se povprečni dosežek naših četrtošolcev v naravoslovnem delu raziskave TIMSS 2015 statistično ne razlikujejo od mednarodnega povprečnega dosežka pri omenjenih nalogah (Japelj Pavešič in Svetlik, 2016). Nekoliko slabše so se naši četrtošolci izkazali pri naravoslovnih nalogah, ki zahtevajo sklepanje, pri katerih so v povprečju dosegli za 5 točke slabši rezultat od svojega skupnega povprečnega dosežka. Zanimivo je, da je omenjena razlika v povprečju manjša pri deklicah kot pri dečkih. Razhajanje med povprečnimi dosežki po ravneh znanja se, kot kažejo trendi zadnjih let, povečuje, saj so se povprečni dosežki med letoma 2011 in 2015 najbolj povečali pri poznavanju dejstev (+ 23 točk) in uporabi znanja (+ 28 točk), najmanj pa pri sklepanju (+ 13 točk).

Tabela 6: Prikaz povprečnih dosežkov slovenskih četrtošolcev na področju naravoslovja glede na kognitivna področja (tovrstna analiza se je izvaja šele od leta 2007). (Vir: Martin in drugi, 2004, 2008, 2012; Japelj Pavešič in Svetlik, 2013, 2016.)

Leto raziskave	Skupni povprečni dosežek	Poznavanje dejstev		Uporaba znanja		Sklepanje	
		Povprečni dosežek pri tej kategoriji	Razlika glede na celotni dosežek	Povprečni dosežek pri tej kategoriji	Razlika glede na celotni dosežek	Povprečni dosežek pri tej kategoriji	Razlika glede na celotni dosežek
2007	518	511	– 7		525	+ 7	
2011	520	518	– 2		518	– 2	
2015	543	541	– 2		546	+ 3	

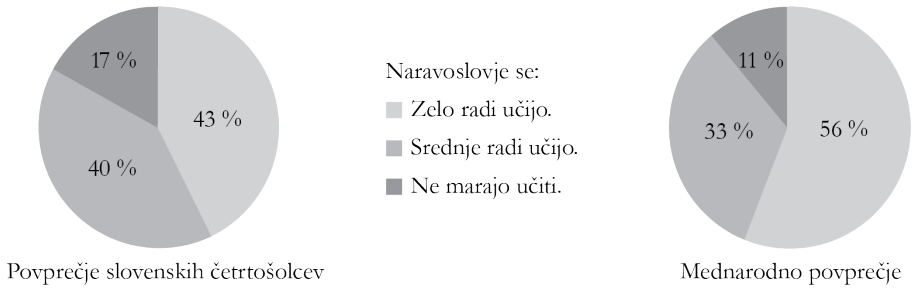
Če smo lahko s trendom naraščanja skupnega povprečnega dosežka v splošnem zadovoljni, pa ne moremo biti zadovoljni, da povprečni dosežek na kognitivnem področju sklepanja, ki velja za zahtevnejše, narašča počasneje kot povprečna dosežka na kognitivnih področjih poznavanja dejstev in uporabe znanja, ki veljata za manj zahtevni. To kaže, da se struktura znanja glede na kognitivna področja na ravni države v povprečju poslabšuje.

Odnos slovenskih četrtošolcev in njihovih staršev do naravoslovja

Pomemben del raziskave TIMSS je tudi ugotavljanje pogojev, v katerih je bilo znanje pridobljeno. Z anketiranjem učencev in njihovih staršev so ugotavljali odnos učencev do učenja naravoslovja, samozavest učencev pri učenju naravoslovja, odnos staršev do naravoslovno-matematičnega izobraževanja ter njihovo podporo pri šolskem delu.

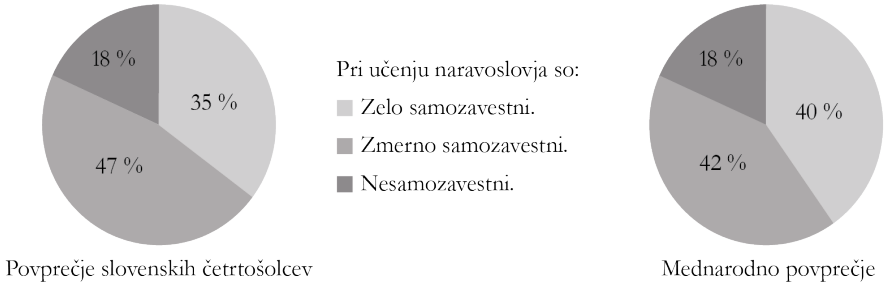
V raziskavi TIMSS 2015 (Japelj Pavešič in Svetlik, 2016) je 56 % vseh četrtošolcev navedlo, da se zelo radi učijo naravoslovje, 33 %, da se srednje radi učijo in 11 %, da se ne marajo učiti naravoslovja. Naši četrtošolci so odgovarjali takole: 43% jih navaja, da se naravoslovje zelo rado učijo, 40 %, da se naravoslovje srednje radi učijo in 17 %, da se naravoslovja ne marajo učiti. Povprečna ocena priljubljenosti učenja naravoslovja slovenskih četrtošolcev je občutno nižja od mednarodne povprečne ocene, še bolj zaskrbljujoče pa je, da ima Slovenija med evropskimi državami drugi najnižji delež učencev, ki se zelo radi učijo naravoslovje.

Raziskava TIMSS 2015 je pokazala vpliv odnosa do učenja naravoslovja na dosežke v znanju naravoslovja (Japelj Pavešič in Svetlik, 2016). V mednarodnem merilu so učenci, ki se zelo radi učijo naravoslovje, v povprečju dosegli 11 točk več kot učenci, ki se ga srednje radi učijo, in 20 točk več kot učenci, ki se ne marajo učiti naravoslovja. Iz tega lahko sklepamo, da bi se povprečni naravoslovni dosežek slovenskih četrtošolcev izboljšal, če bi se izboljšal njihov odnos do učenja naravoslovja.



Slika 4: Prikaz odnosa slovenskih četrtošolcev do učenja naravoslovja, ugotovljenega v raziskavi TIMSS 2015, v primerjavi z odnosom vseh učencev v raziskavi. (Vir: Japelj Pavešič in Svetlik, 2016.)

Tudi glede samozavesti učencev pri učenju naravoslovja zaostajamo za mednarodnim povprečjem (Japelj Pavešič in Svetlik, 2016). V mednarodnem merilu je 40 % učencev navedlo, da so zelo samozavestni pri učenju naravoslovja, 42 %, da so zmerno samozavestni in 18 %, da so nesamozavestni pri učenju naravoslovja (slika 5). Naši četrtošolci so odgovarjali takole: 35 % se jih počuti zelo samozavestne pri učenju naravoslovja, 47 % je zmerno samozavestnih in 18 % nesamozavestnih. Povprečna ocena samozavesti pri učenju naravoslovja slovenskih četrtošolcev je nižja od mednarodne povprečne ocene, ni pa razlika tako velika kot pri povprečni oceni odnosa do učenja naravoslovja.



Slika 5: Prikaz povprečne ocene samozavesti slovenskih četrtošolcev pri učenju naravoslovja, ugotovljene v raziskavi TIMSS 2015, v primerjavi z mednarodnim povprečjem. (Vir: Japelj Pavešič in Svetlik, 2016.)

Raziskava TIMSS 2015 je pokazala vpliv lastne ocene samozavesti pri učenju naravoslovja na dosežke v znanju naravoslovja (Japelj Pavešič in Svetlik, 2016). V mednarodnem merilu so učenci, ki so se opredelili kot nesamozavestni pri učenju naravoslovja, v povprečju dosegli 46 točk manj od tistih, ki so se opredelili kot zmerno samozavestni, in 69 točk manj od tistih, ki so se opredelili kot zelo samozavestni.

V raziskavi TIMSS 2015 (Japelj Pavešič in Svetlik, 2016) se je pokazalo, da ima 34 % naših četrtošolcev starše, ki menijo, da izkazujejo zelo pozitiven odnos do naravoslovno-matematičnega izobraževanja, 63 % ima starše, ki menijo, da imajo zmerno pozitiven odnos do naravoslovno-matematičnega izobraževanja, in 3 % četrtošolcev ima starše, ki menijo, da imajo negativen odnos do naravoslovno-matematičnega izobraževanja.

Slovenija je v tem pogledu na repu razpredelnice držav, ki so sodelovale v raziskavi. Podobno velja tudi za mnenje staršev slovenskih četrtošolcev glede prizadevnosti šol, ki jih obiskujejo njihovi otroci.

Kljub ne najboljšemu odnosu staršev slovenskih četrtošolcev do naravoslovno-matematičnega izobraževanja je raziskava TIMSS 2015 (Japelj Pavešič in Svetlik, 2016) pokazala, da naši četrtošolci v povprečju menijo, da jim starši izkazujejo visoko podporo pri šolskem delu. Tako 21 % slovenskih četrtošolcev meni, da ima doma veliko podpore pri šolskem delu, 78 %, da ima imajo doma srednje veliko podpore pri šolskem delu, in 1 %, da ima doma malo podpore pri šolskem delu. V tem pogledu se Slovenija uvršča na 15. mesto med državami, ki so sodelovale v raziskavi TIMSS 2015.

Raziskava TIMSS 2015 je pokazala vpliv ocene domače podpore pri učenju na dosežke v znanju naravoslovja (Japelj Pavešič in Svetlik, 2016). V mednarodnem merilu so učenci, ki ocenjujejo, da imajo doma veliko podpore pri učenju, v povprečju dosegli 45 točk več kot učenci, ki ocenjujejo, da imajo doma srednje veliko podpore pri učenju. Ta dejavnik je pri slovenskih četrtošolcih torej pozitivno vplival na njihov naravoslovni dosežek.

Učitelji slovenskih četrtošolcev, njihovo poučevanje in pogoji za delo

V raziskavi TIMSS se z anketiranjem učiteljev ugotavlja njihov odnos do poklica, izobrazbo in obseg strokovnega izpopolnjevanja, načine poučevanje naravoslovja idr. Z anketiranjem ravnateljev se ugotavlja pogoje za izvajanje pouka.

V raziskavi TIMSS 2015 (Japelj Pavešič in Svetlik, 2016) se je izkazalo, da ima 52 % slovenskih četrtošolcev učitelje, ki so zelo zadovoljni s svojim poklicem, 42 % jih ima srednje zadovoljne učitelje in 6 % nezadovoljne. Slovenija se je v raziskavi TIMMS 2015 uvrstila na sredino lestvice držav po deležu učencev z zelo zadovoljnimi učitelji. Anketiranje četrtošolcev je pokazalo, da jih v Sloveniji 62 % meni, da so deležni zelo zavzetega poučevanja, v mednarodnem merilu je takih 69 % učencev.

Slabše so se slovenski učitelji v raziskavi TIMSS 2015 (Japelj Pavešič in Svetlik, 2016) odrezali po izobrazbeni strukturi, pri čemer je treba opozoriti, da je primerjava različnih stopenj izobrazbe med državami zelo zahtevna, zato je pri tovrstnih interpretacijah potrebna precejšnja previdnost.

Po ugotovitvah raziskave TIMSS 2015 ima 59 % slovenskih četrtošolcev učitelje z zaključenim vsaj visokošolskim študijem ali 2. stopnjo izobraževanja. Preostalih 41 % naših četrtošolcev učijo učitelji z izobrazbo, ki ni univerzitetna (večinoma gre za diplomante bivših pedagoških akademij), ki je po naši zakonodaji ustrezna (Pravilnik o izobrazbi učiteljev in drugih strokovnih delavcev v izobraževalnem programu osnovne šole, 2015, 8. člen). Če gre ob zgornjem opozorilu v celoti zaupati izsledkom raziskave TIMSS, v mednarodnem merilu 85 % učencev učijo učitelji z dokončano visoko izobrazbo.

Raziskava TIMSS 2015 je pokazala (Japelj Pavešič in Svetlik, 2016), da se slovenski učitelji četrtošolcev v povprečju najredkeje udeležujejo strokovnih izpopolnjevanj s področja didaktike (učitelji 15 % četrtošolcev), najpogosteje pa s področja učnega načrta in informacijskih tehnologij v poučevanju (učitelji 29 % četrtošolcev). Učitelji slovenskih četrtošolcev se v povprečju (z izjemo vsebin, povezanih s preverjanjem in ocenjevanjem znanja) manj udeležujejo strokovnih izobraževanj kot njihovi kolegi iz drugih držav. Do podobnih ugotovitev v povezavi z nadaljnjim izobraževanjem in usposabljanjem učiteljev je prišla tudi Pevec (2012), ki navaja, da je po mnenju učiteljev kakovost tovrstnih izobraževanj v splošnem slaba, zato se jih učitelji le neradi udeležujejo in se raje odločajo za samoizobraževanje ter neformalno izmenjavo izkušenj in znanj s kolegi.

Anketiranje učiteljev v sklopu raziskave TIMSS 2015 je pokazalo (Japelj Pavešič in Svetlik, 2016), da ima v Sloveniji 12 % učencev učitelje, ki izvajajo poskuse pri več kot polovici ur naravoslovja, kar je manj od mednarodnega povprečja (27 %). Po poročanju ravnateljev 23 % slovenskih četrtošolcev obiskuje šolo z ustreznimi prostori za izvajanje poskusov, v mednarodnem okviru ima omenjene pogoje 38 % četrtošolcev.

Po zatrjevanju učiteljev v raziskavi TIMSS 2015 (Japelj Pavešič in Svetlik, 2016) ima 22 % slovenskih četrtošolcev pri pouku naravoslovja dostop do računalnikov, v mednarodnem merilu pa 46 %. Vendar pa je raziskava TIMSS 2015 pokazala, da dostopnost računalnikov ne vpliva na dosežke v znanju naravoslovja (Japelj Pavešič in Svetlik, 2016).

Sklep

Osnovni razlog naše raziskave je odločitev Ministrstva za izobraževanje, znanost in šport, da v letu 2019 Slovenija ne bo sodelovala v mednarodni raziskavi TIMSS. Poudariti želimo, da je omenjena raziskava edina kohortna raziskava naravoslovnega znanja pri nas, saj podobnih raziskav na nacionalnem nivoju ne izvajamo. V Sloveniji tako razen izsledkov raziskave TIMSS nimamo na voljo ustreznih podatkov o znanju naravoslovja v ali po prvem vzgojno-izobraževalnem obdobju, zato je omenjena raziskava ključnega pomena za ugotavljanje uspešnosti poučevanja naravoslovnih vsebin v prvem vzgojno-izobraževanem obdobju. Raziskava TIMSS, v kateri je naša država sodelovala zadnjih 20 let, je izjemno dragocen vir podatkov in omogoča primerjave z drugimi državami. Poleg merjenja znanja namreč ugotavlja tudi pogoje, v katerih osnovnošolci pridobivajo naravoslovno znanje.

Ker Ministrstvo v prihodnjem obdobju podpira predvsem sekundarne raziskave na osnovi izsledkov dosedanjih izvedb raziskave TIMSS, smo v prispevku pripravili kratko pregledno analizo, ki jasno kaže na določena močna in šibka področja v povezavi z naravoslovnim znanjem naših četrtošolcev in pogojev, v katerih je bilo to znanje pridobljeno. Hkrati naša analiza, kljub temu da je osredotočena le na manjši del podatkov, pridobljenih z raziskavami TIMSS, jasno kaže, kako koristna in nepogrešljiva je raziskava TIMSS za ugotavljanje kakovosti pouka naravoslovja, odkrivanje pomanjkljivosti in vzrokov zanje.

Rezultati raziskave TIMSS 2015 kažejo, da smo lahko na področju naravoslovja v prvem vzgojno-izobraževalnem obdobju v splošnem zadovoljni. Raven naravoslovnega znanja je v mednarodnem merilu dobra, večji razlik v znanju med spoloma ni, znanje na državni ravni je homogeno, trendi so pozitivni. Podrobnejša analiza rezultatov raziskave TIMSS 2015 pa je razkrila tudi več manj razveseljivih ugotovitev, kot na primer slabša zmožnost sklepanja ter bolj odklonilno stališče učencev do učenja naravoslovja od mednarodnega povprečja. Tudi po izobrazbi učiteljev, njihovem strokovnem izpopolnjevanju in pogojih za izvajanje pouka zaostajamo za mednarodnim povprečjem. Raziskava TIMSS ugotavlja, da večina dejavnikov, v katerih zaostajamo za mednarodnim povprečjem, vpliva na izkazano naravoslovno znanje, zato bi bilo smiselno proučiti razloge zanje in na osnovni tega zastaviti ustrezne projekte na državni ravni za zmanjšanje omenjenih zaostankov

Summary

The present study is an overview of Slovenian elementary school evaluation of students' knowledge in the early grades (1-4) regarding natural science. On the Slovenian national level, science knowledge in the first three years of elementary school is not measured and evaluated regularly. Therefore, we have focused primarily on the results of the international survey TIMSS (Trends in International Mathematics and Science Study), which measures the mathematical and natural science knowledge of students from various countries all over the world compared to the TIMSS results of fourth-grade students.

The TIMMS survey is performed every four years under the patronage of the International Association for the Evaluation of Educational Achievement (IEA) and is conducted in various countries. The basic implementation of the survey involves students in the 4th and 8th grades of elementary schools, with at least 4000 students from each participating country. In addition to measuring students' knowledge through various questionnaires, the TIMSS survey measures the conditions under which the scientific knowledge is acquired and recognizes students' attitudes towards science. The survey involves interviewing the parents, teachers and school principals whose students are involved in the survey, hence providing information on the factors that influence the acquisition and demonstration of knowledge.

Slovenia participated in TIMMS from 1995 to 2015. For Slovenian fourth-graders, a steady increase compared to the international average was shown. In addition, in 2015, they reached an average achievement of 543 points, exceeding the international average by 43 points. This very good scientific knowledge ranked them 11th among 47 participating countries.

The latest TIMMS survey results (from 2015) indicate that generally there is a satisfactory level of natural science knowledge among students in the first three years of elementary school. Furthermore, there are no gender differences shown, and national knowledge in natural sciences appears homogeneous.

However, a closer analysis reveals a number of less encouraging findings, such as poorer ability of Slovenian students to draw conclusions based on factual knowledge. This could indicate that the knowledge structure in relation to cognitive domains is, on average, deteriorating at the national level. Furthermore, the positive attitude towards science is lagging behind. Slovenian fourth-graders show less confidence in science teaching, which has proven to have an impact on science knowledge achievement. Even when we focus on teacher education, their

professional development and the conditions of teaching, the results indicate that Slovenia lags behind the international average.

Analysis of the TIMSS results indicates that most of the factors identified for Slovenia that lag behind the international average have an impact on natural science knowledge. Consequently, it would be sensible to discover the reasons for these and to develop appropriate projects on the national level. One solution would be to implement a greater proportion of experiential learning and improvement in learning materials, which together would emphasize the higher taxonomic levels of knowledge

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Prispevki v zbornikih: priimek, začetnica imena avtorja, leto izida, naslov prispevka, podatki o knjigi ali zborniku, strani, kraj, založba.
Fošnarič, S. (2002). Obremenitve šolskega delovnega okolja in otrokova uspešnost. V M. Juričič (ur.), *Šolska higiena: zbornik prispevkov* (str. 27–34). Ljubljana: Sekcija za šolsko in visokošolsko medicino SZD.

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