Models of Individualized Instruction and Possibilities for their Application in Initial Mathematics Teaching – Teacher Perceptions

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Abstract

This paper presents the results of the research on teacher perceptions of individualized teaching and its application in initial mathematics teaching. Twelve models have been designed for four of its types: programmed, problem-based, computer-assisted instruction and three levels of individualization approach. Teachers' opinion on the validity of the designed models, the possibilities of applying individualized instruction in initial mathematics teaching, their training and skills to apply it, and the extent to which these are applied in the initial mathematics teaching were examined. The survey was conducted on a sample of 114 teachers who positively evaluated the validity of the designed models. Moreover, the results obtained indicate that teachers most often choose to use three levels of individualization approach, as well as individualized instruction using worksheets. Problem-based instruction is used very rarely. Most of them think that they are not sufficiently trained and skilled to use individualized instruction.

Keywords: individualized instruction, initial mathematics teaching, content modelling, teacher perception

Introduction

Providing an education of good quality that will enable each student to accomplish his/her potential and acquire appropriate skills in a society that constantly changes, where knowledge quickly becomes obsolete and where it is difficult to predict future changes, is a challenge that almost all education systems worldwide are faced with. In a number of changes directed towards this goal, it is important to introduce new and innovative teaching methods that will provide better learning outcomes than the traditional one "since human knowledge increases with such alarming speed, to focus exclusively on academic content is to misuse students' valuable time in school"(Dell'Olio & Donk, 2007, p. 32).

As a response to the current challenges that society imposes on education, contemporary schools "focus on the dominant students' activities, on the development of his/her personality and individuality" (Milijević, 2003, p. 37).The teacher's role is "to guide students into the world of knowledge, to show them how to learn" (Milijević, 2003, p. 15). Accordingly, as a teaching system that directs the teaching process towards the developmental, problem-based and inquiry-based learning, where students have the greatest possible active role in discovering the truth about the concepts that are the subject of study, individualized instruction is in line with the aspirations of contemporary society to affirm students in the classroom. By using individualized instruction, teachers' role also changes, since their activities focus on adapting teaching to the abilities, knowledge and affiliations of students.

Bearing in mind that the receptive mode of student learning decreases in the contemporary mathematics curriculum, while activity and individuality are more and more favoured, the research into the possibilities of applying individualized instruction in initial mathematics teaching is of even greater significance, as shown by many studies into this topic. Empirical studies of the efficiency of individualized instruction (Ilić, 1984), and its types (see, Petrović, 2001; Kirby & Radford, 1976) have identified significant advantages of this type of instruction over traditional teaching, and that the issue of individualized instruction is at the core of lesson organization.

Moreover, studies that have dealt with the skilfulness of teachers to apply individualized instruction (Lazarević, 1996) and their perception of it (Kundačina, 2001) indicate that individualized and differentiated instruction are not at the desired level yet, that teachers need training in the form of recorded lessons and teaching practice, since the application of certain teaching methods and types of individualization is essentially preconditioned by the training and skilfulness of teachers; moreover, it is necessary to adapt school textbooks for individualized and differentiated instruction.

Due to the above, as well as due to the fact that, despite all the advantages offered by individualized instruction, it is still insufficiently used in mathematics teaching, this paper will include the following: theoretical study of individualized instruction and some of its types; design of the model for initial mathematics teaching using individualized instruction; and empirical research of teachers' perceptions of individualized instruction and its implementation in early elementary school years.

1. Theoretical Considerations

1.1. Individualization of Teaching

Considering the large array of approaches to individualization described in the literature, it is puzzling that educators lack a generally accepted working definition of individualized instruction. The idea is not new and many researchers have worked on its conceptual definition (Gage & Berliner, 1975; Sayre, 1975; Mandić, 1987; Poljak, 1990; Laketa & Vasilijević, 2006; etc.) According to Heathers (1977), individualized instruction consists of any steps taken in planning and conducting programs of studies and lessons that suit them to the individual student's learning needs, learning readiness, and learner characteristic or „learning style" (p. 342). On the other side, Gibbons (1970), define it as a „phylum rather than a species of approaches to teaching" (p. 28). In any case, everyone agrees that it is the teaching system tailored to the skills, abilities, and interests of the individual student (Collins English Dictionary).Where differences in the understanding of the concept still occur, they come from a different understanding of individualization and its goal. Individualization is based on an individual approach, but it encompasses much more. Namely, "to respect the individual characteristics of students means, in fact, to strive – always and as consistently as possible– that each student is provided the teaching material matching his/her abilities, at the cognitive level available to him/her, through the processes tailored to his/her personality and at the pace that suits them. This effort is called individualization of instruction, and its full implementation is called individualized instruction" (Bakovljev, 1998, 34)

Bearing in mind that contemporary teaching strategies provide wide array of opportunities to tailor and adapt instruction and learning process to the specific characteristics of individual students, many of them can be considered forms of individualized instruction. According to Gibbons (1970) "One way of analysing the collection of individualized programs, practices, and materials is to sort out families of approaches and to organize them into a simple classification system according to their distinguishing characteristics. The different species within families can be more precisely described in profiles that outline the treatment given to each major element of instruction. The ideal implicit in the programs seems to be separate, appropriate instruction for each student, but the ideal program has yet to be developed" (p. 28). In teaching theory and practice, the following types of individualized instruction are most often mentioned: teacher-directed instruction, three levels of individualization, usage of worksheets, differentiated homework assignments, programmed instruction, problem-based instruction, inquiry-based learning, computer assisted instruction, etc.

The starting point for the individualisation of instruction is the curriculum, that is, the goal and objectives of teaching which determine what is to be achieved with education within certain course areas. In order for the teaching goals and objectives to be applied during individualized instruction, they must be clear, specific, usable for those who work on their achievement, and they have to be in line with one of the modern taxonomies. Bloom's Taxonomy (Bloom, at. all, 1956) within the cognitive domain proved to be very effective in improving the teaching and learning process when working with all types of students, both with those who are average and with those who lag behind, and those who are intellectually gifted and can adopt knowledge much faster. "The Taxonomy of Educational Objectives is a scheme for classifying educational goals, objectives, and, most recently, standards. It provides an organizational structure that gives a commonly understood meaning to objectives classified in one of its categories, thereby enhancing communication" (Krathwohl, 2002, 218). Many proponents of behavioural learning theories have insisted on the strict hierarchy of learning objectives.

In our case, the taxonomic model of operationalization of mathematics teaching goals and objectives was used to classify the objectives based on levels of knowledge (Bogdanović & Malinović-Jovanović, 2009, 620) which is, on the one hand, in line with Bloom's Taxonomy within the cognitive domain, and on the other hand, with the requirements concerning the evaluation of knowledge and assessment of students required by the Primary School Mathematics Curriculum in Serbia (*The Curriculum for First, Second, Third and Fourth Grade of Primary Education, 2004, 2005, 2006, 2008, 2010, 2011,2013, 2014*). The taxonomy contains five categories: recognition, reproduction, comprehension, operability (application and generalization) and creative problem-solving (analysis, synthesis and evaluation according to Bloom). Categories are hierarchically arranged based on the level of knowledge in terms of quality, and subcategories are defined for each category which explain in more detail the educational goals of each category.

1.2. Models of individualized instruction in initial mathematics teaching

The modelling of course content is a complex, multi-layered process whose main goal is to design and create a model that will be used for education purposes and for scientific research in order to get to know about concepts, phenomena and processes, and their application in order to increase efficiency and quality of implementation. Miljević (2007) emphasizes that "modelling is a rational, systemic, complex process of proper representation of important traits of processes, phenomena or facts as a whole. In other words, modelling is the process of model design. A model is an imitation, prototype or projection of an object – a piece of an existing, past or possible future reality" (p. 172). In teaching, a model and modelling usually relate to the structure of course content and its role, that is, the processes and outcomes of the appropriate content structure. Thus, course content models have a dual role: rational introduction of students into modern science and flows of life, and optimum development of their abilities (Malešević, 2012, 279).

In this paper, the concept of model is seen as the structured content of initial mathematics teaching using individualized instruction, and the concept of modelling is considered to be the operationalization of content and individualization of the teaching process based on the appropriate form of individualized instruction. Models are not static categories – they can be modified and changed. By forming and solving mathematical models with more freedom and with constant evaluation of educational aspects of mathematics teaching, differentiation and individualization of this extremely complex and dynamic course is ensured. There is no universal model for the implementation of individualized instruction. The structure of the model depends on the type of individualized instruction to which it relates. What is common to individualized instruction in general, regardless of its types, is that it is structured in such a way that it allows the learning process to take place in three phases: preparatory, operational, and verification phase. The structure of the content to be introduced during each of these phases depends on the form of individualized instruction and the type of the lesson. For each phase, average duration time is established, as well as the basic structural and methodological components. Methodological components that affect individualization within individualized instruction are as follows: educational aims and objectives; teaching methods; teaching types; teaching technologies and aids. The overall goal of a certain course unit is immediately identified for all the content belonging to that specific course unit, while other methodological components are usually given separately for each phase.

In the text that follows we will present possible models for certain types of individualized instruction of mathematics in early elementary school years.

1.2.1. Models of problem-based instruction

Problem-based learning, can be implemented at several levels based on the level of student activity in problem solving (problem-solving monologue, problem-solving dialogue, independent problem-solving, and independent formation of concepts and problem-solving), which allows to differentiate the entire course and flow of problem-based instruction.

Differentiation and individualization mostly happen in the operational and verification phase. However, they practically already start in the preparatory phase when formulating the problem, since this particular phase can also be divided into several levels depending on students' autonomy in learning. The most room for differentiation is provided in the hypothesis verification stage and problem-solving stage, since it is during this stage that the independence and the pace of learning of students is the most prominent.

In addition to general professional and didactic/methodological requirements in problem-solving learning, it is necessary to specify the appropriate organizational structure. Depending on these components, different models can be designed. One of the possible theoretical models that could be used for teaching of initial mathematics through problem-solving learning approach in individualized classes can be constructed as follows:

- Design a problem-based scenario and formulate the issue – in order to revise and review previously learnt and discover the unknown;
- Analyse the problem and choose the hypothesis;
- Verify the hypothesis;
- Analyse the results (solution verification) and write a conclusion;
- Solve the exercises;
- Apply conclusions in new scenarios and give homework

In this case, the lesson should be carried out following the above mentioned phases, but this should not be necessarily strictly abided by. Also, the usual split of mathematics lesson into the preparatory, operational and verification phase can be abided by following this proposed structure as well.

1.2.2. Models of instruction at three levels of individualization

In practice, the differentiation of course content and the requirements of initial mathematics lessons is carried out at three levels, which does not mean that it should only be done at three levels, as the main goal is a complete individualization of teaching and learning. Based on the differentiation levels, students are divided into homogeneous groups (below average, average, and above-average). For this kind of teaching and learning to work, it is necessary to organize course content so that students can independently study them in the classroom, which means that they need to be differentiated based on complexity, and in accordance with one of the taxonomies and with the abilities of students. Also, exercises and questions are chosen based on the requirements of course objectives and the levels of knowledge to be evaluated. Therefore, the basic criteria for differentiation and the choice of exercises and questions are the amount (quantity) of knowledge and the quality of knowledge that a particular group of students should have after the learning process, that is, at the end of a lesson. However, we should have in mind that quantity and quality are mutually conditioned and dependent, that is, reaching a higher level implies mastering the previous level and a certain amount of knowledge that comes with it.

Taking students from a lower to a higher level can be enabled by structuring exercises within a certain level. Thus, course contents for the different groups of students can partly overlap, which means that a part of the content covered by the below-average group might match a part of the content covered by the average group, or, a part of the content covered by the average group might be the same as the content covered by the above-average group. Jukić, Lazarević and Vučković (2002), structured the tasks and exercises for below-average, average and above-average students, so each subsequent level contains up to one-third of the exercises from the previous level. This way of structuring the exercises is more helpful when there is the need to verify whether a student can move from one level to the next. In practice, groups are usually not created based on levels of knowledge, but students are rather allowed to choose work sheet based on the level of task complexity. In this way, it is not necessary to group students, since, on the one hand, students themselves are enabled to assess the level of their knowledge, and on the other hand, if they successfully solve the first level of tasks, they can move to the next, more complex level.

Based on the structure of course content and lesson format, the model of this type of individualized instruction differs from the model of problem-based learning. Therefore, we provide a structural teaching plan that allows to choose exercises and tasks by level of complexity:

Preparatory phase

1. Course content preparation – revision of content necessary to cover and keep up with the course unit; reviewing and eliminating any possible doubt regarding the creation of homework assignments;
2. Psychological preparation – explanation of the objectives and teaching methods, introduction to the course unit;
3. Technical preparation – create groups and distribute learning material and aids to students.

Operational phase

4. Individual (group) activities of students based on one of the three groups of tasks by complexity;
5. Feedback (self-evaluation of answers and solutions);

6. Joint analysis of the work done on solving the exercises – pointing to errors made; discuss about the evaluation.

Verification phase

7. Communicate the results by level of complexity;
8. Present the best solutions;
9. Assess workflow;
10. Transfer a student (or a group) to the next or previous level;
11. Assign homework and instructions.

1.2.3. Models of programmed instruction

Structuring and differentiation of course content and course requirements is important when designing theoretical models in programmed instruction. The process of structuring course content in this type of instruction includes: informing students about the exercises they need to master; breaking down each exercise into its components; providing instruction on how to approach certain exercises and tasks; allowing students to analyse phenomena and processes, to perceive their logical structure and understand the essence of each exercise and task; allowing logical transfer of students from one exercise and task to the next one which requires a sequence of thought processes and operations necessary for problem solving. Programmed instruction enables, to a greater or lesser extent, different aspects of individualization, such as: the pace of learning, the way of content adoption, while the content itself can be individualized.

The course content is programmed and the frame (step) is the smallest logical unit within a course unit that contains several components: information to be conveyed to the student, exercise (question) student needs to solve/answer based on the information provided, time to solve/answer the exercise (question), students are provided feedback about whether or not their response is correct.

A structured plan for the implementation of programmed instruction, in the stage referring to the preparatory and operational phase, does not essentially differ from individualized instruction, except that during the technical preparation stage, students are handed course material and given instructions for learning, while the individual activities of students during the operational phase include mastering the programmed material. During the verification stage, it is checked whether course material has been adopted and mastered, and homework and instructions are assigned as well. The structure of programmed material varies depending on the type of the lesson, as well as on the type of programmed material.

2. Methodological Framework

The goal of this research was to identify the views and perceptions of teachers on individualized instruction and its application in the initial teaching of mathematics. For this purpose, models of individualized instruction were designed, the structure of which was aligned with the theoretical concepts, that is, with the organizational structure of each of the types of individualized instruction covered by this research.

Considering the goal set, the teachers' perception of whether it is possible to use individualized instruction in the initial mathematics lessons and the validity of designed models was examined. Moreover, it was verified how much teachers apply individualized instruction and whether they feel they are trained and skilled enough to use it. The initial sample included 138 teachers who teach early elementary school students. These teachers came from 12 elementary schools in Pčinjski, Toplički and Jablanički district in Serbia. The sample included both rural and non-rural schools. Based on the results obtained by interviewing the teachers, a final sample was chosen and it included 114 teachers who correctly answered the questions related to the familiarity with the characteristics of individualized instruction and its types. Table 1 show the sample based on the teachers' level of education and work experience, which served as independent variables in this research.

Table 1Research sample

	Education level		Work experience			Total
	University degree	Associate degree	< 10	11 – 20	> 20	
f	86	28	31	48	35	114
%	75.43	24.57	27.19	42.10	30.71	100

On the one hand, the models designed are based on methodical rules which are abided by when constructing and forming mathematical concepts, and on the other hand, on the principles of individualized instruction.

During the model design phase, we made sure we included course content that is being studied in the first four grades, and we also made sure that the chosen content is suitable to be studied using the individualized instruction approach. The model structure was designed to model both the content and the flow of students' activities with the aim to develop cognitive skills that would enable them to have a more efficient cognitive process. The goals and objectives specified in the models were operationalized so that students themselves can also assess whether they have achieved them. Each model contains a structured lesson plan where students' and teachers' activities for each phase of the lesson are specified. Moreover, the model also contains all didactic components relevant to the model – teaching methods, forms of teaching, teaching tools and aids, and average time for their implementation during each phase of the lesson. Lastly, the operationalization of the structured lesson plan per phase was provided, depending on the type of individualized instruction the model related to. Each model also contained feedback about students' success or failure in acquiring knowledge, skills and habits; criteria were also given which were used to choose questions and exercises based on difficulty level. A total of 12 models were designed for four types of individualized instruction, which are shown in Table 2.

Table 2 Models of individualized instruction used in the research

Type of instruction	Course unit	Type of lesson	Grade
Problem-based instruction	Addition – Sums up to 20	Presentation	1st
	Divide a sum and difference of numbers by number	Presentation	2nd
	Constant difference concept	Presentation	3rd
	Problem-solving tasks	Systematization	4th
Programmed instruction	Circumference of a rectangle	Presentation	3rd
	Divide a sum and difference of numbers by number	Presentation	3rd
Three levels of individualization	How is quotient affected by change in divisor value	Revision	3rd
	Multiplication and its connection with addition	Revision	2nd
	How is product affected by change in factor value	Presentation	4th
	Subtract a sum of numbers from a number	Revision	2nd
Computer-assisted instruction	Missing addends in equations	Presentation	2nd
	Problem solving with addition and subtraction	Systematization	4th

Within the descriptive method, the survey and scaling technique were applied, and as a research tool questionnaire was filled out by teachers. This questionnaire included multiple choice questions, as well as of questions that contained Likert-type scale. The questionnaire consisted of three sections. The first section included questions related to the knowledge of the structure of individualized instruction and its types. These questions were used to select the final sample of respondents whose answers were taken into consideration and which were also used to analyse the results of the research. The second section consisted of questions relating to the possibilities of applying individualized instruction in the initial teaching of mathematics. The third section – questions related to the validity of the designed models. Apart from the teachers' opinion, the validity of models was verified based on the theoretical analysis of contemporary definition of individualized instruction and its alignment with the structure of the designed models.

Empirical data were analysed quantitatively and expressed in frequencies and percentages. T-test was used to determine the statistical significance of the differences between the indicators of dependent variables and the categories of independent variables (education level and work experience).

3. Research Results

In order to identify teachers' perceptions of the possibilities of applying individualized instruction in initial mathematics teaching, as well as the validity of the designed models, we were interested in whether there is a difference in the perceptions of teachers of different levels of education and work experience. Therefore, the results were analysed in relation to these two variables.

3.1. Possibility of applying individualized instruction in initial mathematics teaching

The analysis of teachers' perceptions of the possibility of applying individualized instruction in the initial mathematics teaching was carried out in relation to: whether the initial mathematics course material is suitable to be studied using the individualized instruction approach, which types of individualized instruction deliver the best results in the classroom, the reasons why the teaching process should be tailored to individual students' abilities.

Moreover, the teachers were asked to which extent they apply individualized instruction when teaching mathematics, what are the reasons why they may not decide to use it, and what is their opinion on whether they feel they are qualified and skilled enough to teach mathematics using some of the types of individualized instruction.

The results relating whether the initial mathematics course material is suitable to be studied using the individualized instruction approach are given in Table 3.

Table 3 Distribution of frequencies and percentage of answers in relation to the education level and work experience of the respondents

Suggested answers	Education level				Work experience						∑	
	Univer. degr.		Assoc. degr.		< 10		10 – 20		>20			
	f	%	f	%	f	%	f	%	f	%	f	%
Suitable	16	18.6	8	28.57	4	12.90	12	25.00	8	22.86	24	21.05
Partly suitable	69	80.23	19	67.86	27	87.01	35	72.92	26	74.29	88	77.19
Not suitable	1	1.16	1	3.57	0	0	1	2.08	1	2.86	2	1.75

Based on the results obtained, we can conclude that most teachers (77.19%) believe that mathematics course content is partially suitable to be studied using individualized instruction. Only 21.05% of them think they are suitable, while there are some (1.75%) who consider that mathematics course content is not suitable at all to be studied using some type of individualized instruction. Moreover, the calculated t-values of the difference between the answers given by teachers with university degree and teachers with associate degree (in percentages) does not point to a statistically significant difference in their opinions – $t(23) = -0,80$, $p = 0,4319$in the case of teachers who believe that the content is suitable, and $t(87) = 1.88$, $p = 0,0635$in the case of teachers who believe that the content is partly suitable. When it comes to the work experience of the interviewees, a statistically significant difference exists only in one case – between the opinions of teachers with less than 10 years of work experience and those between 10 and 20 years of work experience–$t(60) = 1.96$, $p = 0,05$.

With regards to this, it was checked how suitable it was to use certain types of individualized instruction to teach initial mathematics but depending on the lesson type. The results of this analysis are given in Table 4.

Table 4 The suitability of using certain types of individualized instruction to teach initial mathematics depending on lesson type

Type of instruction	Lesson type	Education level				Work experience						∑	
		Univer. degr.		Assoc. deg.		< 10		10 – 20		> 20			
		f	%	f	%	f	%	f	%	f	%	f	%
Three levels of individualisation	P	16	18.6	4	14.29	5	16.13	10	20.83	5	14.29	20	17.54
	RPS	70	81.4	24	85.71	26	83.87	38	79.17	30	85.71	94	82.46
Use of worksheets	P	2	2.33	1	3.57	2	6.45	0	0	1	2.86	3	2.63
	RPS	84	97.77	27	97.43	29	93.55	48	100	34	97.14	111	97.37
Computer-assisted instruction	P	45	52.33	10	35.71	17	54.84	25	52.08	13	37.14	55	48.25
	RPS	41	47.77	18	64.29	14	45.16	23	47.92	22	62.86	59	51.75
Problem-based instruction	P	52	60.47	15	53.57	20	64.52	25	52.08	22	62.86	67	58.77
	RPS	34	39.53	13	46.43	11	35.48	23	47.52	13	37.14	47	41.33
Programmed instruction	P	54	62.80	16	57.14	18	58.06	30	62.50	22	62.86	70	61.40
	RPS	32	37.20	12	42.86	13	41.94	18	37.50	13	37.14	44	38.60

Abbreviations: *P – presentation, RPS – revision, practice, systematization*

Based on the corresponding percentages of teachers' answers, we can see that most teachers believe that three levels of individualization approach (82.46%) and the use of worksheets (97.37%) are suitable for revision, practice and systematization lessons, while opinions are divided when it comes to the other three types of individualized instruction. Moreover, the corresponding *t*-values for the difference in teachers' perceptions were calculated in those cases where the difference in the given answers was the largest and where it was expected that this difference existed which indicate that the difference in teachers' perception, based on their education level and work experience, is not statistically significant.

Teachers' opinions on which type of individualized instruction can deliver the best results in the classroom are shown in Table 5. It should be noted that teachers were asked to choose one of the suggested types of instruction.

Table 5 Types of individualized instruction which could deliver the best results in the classroom

Type of instruction	Education level				Work experience						∑	
	University d.		Associate d.		< 10		10 – 20		>20			
	f	%	f	%	f	%	f	%	f	%	f	%
Three levels of individ.	34	39.53	13	46.43	11	35.48	22	45.83	14	40.00	47	41.23
Use of worksheets	18	20.93	3	10.71	5	16.12	9	18.75	7	20.00	21	18.42
Computer-assisted instr.	19	22.09	7	25.00	10	32.26	10	20.83	6	17.14	26	22.81
Problem-based instr.	6	6.98	2	7.14	2	6.45	3	6.25	3	8.57	8	7.02
Programmed instruction	9	10.46	3	10.71	3	9.68	4	8.33	5	14.29	12	10.53

Based on the results shown in the table, we can see that the majority of teachers (41.23%) have opted for the three levels of individualisation approach, followed by computer-assisted instruction and use of worksheets (22.81% and 18.42%), while only 7.02% gave preference to problem-based instruction. 10.53% of surveyed teachers chose programmed instruction. T-values for the difference in teachers' perceptions were calculated in those cases where the difference in the given answers was the largest and where it was expected that this difference existed. The *t*-value obtained in the case of teachers of different education level who have opted for the use of worksheets is $t(20) = 0.89, p = 0.384$ is not statistically significant. Moreover, when it comes to teachers with less than 10 years and more than 20 years of work experience, the t-value obtained is $t(15) = 0.97, p = 0.3474$ and it is not statistically significant.

We also asked teachers which reasons they deem necessary or desirable to adjust teaching to different learning abilities of students, or which reasons they believe to be of no relevance to the teaching process. The reasons related to student activity and teacher activity were considered: 1. Developing students logical reasoning, building self-confidence in overcoming obstacles; 2. Focus the teaching process on developmental, problem-oriented, research activities, which encourage student creativity; 3. Develop intrinsic motivation in students in terms of their needs, desires, interests and curiosity to learn something, 4. Structure the course material based on students' abilities, prior knowledge, experiences and interests, pace of learning, attitude towards learning, readiness to learn, and 5. Teacher satisfaction due to greater professional success. The results obtained are shown in Table 6.

Table 6 Reasons to adapt teaching process to students needs

R	Suggested answers	Education level				Work experience						∑	
		Univers. degree		Assoc. degree		< 10		10 – 20		> 20			
		f	%	f	%	f	%	f	%	f	%	f	%
1.	Not significant	0	0	1	3.57	0	0	0	0	1	2.86	1	0.88
	Desirable	48	55.81	16	57.14	16	51.61	28	58.33	20	57.14	64	56.14
	Necessary	38	44.19	11	39.29	15	48.39	20	41.67	14	40.00	49	42.98
2.	Not significant	0	0	0	0	0	0	0	0	0	0	0	0
	Desirable	38	55.81	13	46.43	14	45.16	21	43.75	16	45.71	51	44.74
	Necessary	48	44.19	15	53.57	17	54.84	27	56.25	19	54.29	63	55.26
3.	Not significant	1	1.16	0	0	1	3.22	0	0	0	0	1	0.88
	Desirable	35	40.70	14	50.00	15	48.39	21	43.75	14	40.00	49	42.98
	Necessary	50	58.14	14	50.00	15	48.39	27	56.25	21	60.00	64	56.14
4.	Not significant	1	1.16	1	3.57	0	0	1	2.08	1	2.86	2	1.76
	Desirable	43	50.00	13	46.43	19	61.29	22	45.84	15	42.85	56	49.12
	Necessary	42	48.84	14	50.00	12	38.71	25	52.08	19	54.29	56	49.12
5.	Not significant	1	1.16	0	0	0	0	1	2.08	0	0	1	0.88
	Desirable	46	53.49	14	50.00	20	64.52	24	50.00	17	48.57	60	52.63
	Necessary	39	45.35	14	50.00	11	35.48	23	47.92	18	51.43	53	46.49

The results obtained indicate that teachers' opinions are divided when it comes to the necessity to individualize the teaching process. A higher percentage of them selected reasons 1 and 5 as desirable – 56.14% and 52.63%, but not necessary for the individualization of teaching.

On the other hand, a higher percentage of teachers (55.26 and 56.14%) think that 2. and 3. reason are necessary for the individualization of teaching. Thus, the difference in teachers' perceptions as to whether the reasons suggested are desirable or necessary is statistically significant in the case of reason 1 and 3 – $t(112) = 1.9879, p = 0.0493$in both cases, while it is not significant in the remaining cases ($t(113) = 1.6218, p = 0.1076; t(112) = 0.7886, p = 0.4320$in the case of reason 2 and 5, respectively). T-values obtained that refer to the differences in teachers' perceptions based on their education level, in the case of reason 3 ($t(48) = -0.91, p = 0.3674$), and based on their work experience in the case of reason 3($t(35) = -0.98, p = 0.3338$), 4. ($t(33) = 1.53, p = 0.1355; t(30) = -1.22, p = 0.2320$) and of reason 5 ($t(36) = 1.38, p = 0.1761; t(28) = -1.22, p = 0.2326$), do not point to any statistically significant difference.

We were interested in how often they apply this type of instruction in their classrooms, and if they believe that they are sufficiently qualified and skilled to use any of the individualized instruction approach types. The results obtained are shown in Table 7 and 8.

Table 7 How often teachers apply individualized instruction

Type of instruction	Lesson type	Education level				Work experience						∑	
		Univer. deg.		Assoc. deg.		< 10		10 – 20		> 20			
		f	%	f	%	f	%	f	%	f	%	f	%
Three levels of individualisation	Often	22	22.58	6	21.42	6	19.35	14	29.17	8	22.86	28	24.56
	Sometimes	59	68.60	22	78.57	23	74.19	32	66.67	26	74.29	81	71.05
	Never	5	5.81	0	0	2	6.46	2	4.16	1	2.86	5	4.39
Use of worksheets	Often	63	73.25	20	71.43	22	70.97	34	70.83	28	80.00	83	72.81
	Sometimes	22	25.58	8	28.57	8	25.80	14	29.17	7	20.00	30	26.32
	Never	1	1.16	0	0	1	3.23	0	0	0	0	1	0.88
Computer-assisted instruction	Often	10	11.63	2	7.14	5	16.13	3	6.25	4	11.43	12	10.53
	Sometimes	74	86.05	24	85.71	26	83.87	43	89.58	29	82.86	98	85.96
	Never	2	2.33	2	7.14	0	0	2	4.17	2	5.71	4	3.51
Problem-based instruction	Often	5	5.81	3	10.71	1	3.23	2	4.17	5	14.29	8	7.02
	Sometimes	40	46.51	17	60.71	14	45.16	22	46.25	21	60.00	57	50.00
	Never	41	47.67	8	28.58	16	51.61	24	50.00	9	25.71	49	42.98
Programmed instruction	Often	47	54.65	12	42.86	18	58.06	25	52.08	16	45.71	59	51.75
	Sometimes	37	43.02	15	53.57	12	38.71	23	47.92	17	48.57	52	45.61
	Never	2	2.33	1	3.57	1	3.23	0	0	2	5.71	3	2.63

The data shown in the table indicate that most teachers *often* use worksheets sheets (72.81%), *sometimes* apply three levels of individualization approach and problem-based instruction (71.05% and 85.96%), while programmed instruction is applied often or sometimes (51.75% and 45.61%). Only 7.02% of teachers apply problem-based instruction *often*, while most of them apply it *sometimes* – 50.00%. Apart from problem-based instruction (42.98%), there is a very small number of teachers who never apply any of the suggested types of individualized instruction. There are differences in teachers' opinions based on their education level and work experience only considering problem-based teaching, in the following cases: in the case of education level, between teachers who never use this type of instruction – $t(48) = 1.96, p = 0.05,$ and in the case of a difference in years of service, between those who have between 10 and 20 years, and those with more than 20 years of service –$t(32) = 2.07, p = 0.0464$. In the remaining cases, the difference is not large enough to be statistically significant.

We also asked teachers to state the reasons why they may not opt to use individualized instruction when in initial mathematics classes. Most of them said that much more time is needed to teach course material by using one of the suggested types of instruction (84.32%), and that lesson planning is much more complex (92.15%).

Table 8 Teachers' skilfulness to teach mathematics using individualized instruction approach

Suggested answers	Education level				Work experience						∑	
	University degree		Associate degree		< 10		10 – 20		>20			
	f	%	f	%	f	%	f	%	f	%	f	%
Fully skilled	20	23.26	9	32.14	6	19.35	10	20.84	13	37.14	29	25.44
Partly skilled	65	75.58	18	64.29	25	80.65	37	77.08	21	60.00	83	72.80
Not skilled	1	1.16	1	3.57	0	0	1	2.08	1	2.86	2	1.76

Regarding teachers' skilfulness to perform individualized instruction, the majority of them (72.80%) consider that they are partly skilled to apply some form of individualized instruction. 25.44% of them think that they are fully trained, while there are some (1.76%) who believe that they are not skilled at all to apply any form of individualized instruction. A statistically significant difference in teachers' perceptions and opinions exists in the case of those who consider that they are partly skilled (based on the work experience variable) – $t(45) = 2.202$, $p = 0.0329$ and $t(57) = 1.998$, $p = 0.05$, specifically between the teachers with less than 10 years and between 10 and 20 years of work experience, and those with more than 20 years of work experience. In the remaining cases, the difference is not large enough to be statistically significant.

3.2. The validity of designed models

For each of the models designed, teachers were asked to assess: how suitable each model is for studying the content to which they relate, whether this content is linked to previous knowledge and experience of students, how it affects the discovery of essential relationships and links among the concepts to which it relates, as well as how it affects the development of students' thought process, that is, the quality of the acquired knowledge in terms of its durability, the ability to apply it in real life situations and build critical thinking, as well as whether it affects student motivation. The results will be presented in relation to the evaluation of each model based on the listed components (Table 9). Moreover, in order for a model to be claimed to be suitable, it requires at least 4 out of 5 components to be positively assessed.

Table 9 The validity of individualized instruction models designed

Type of instruction	Model valid	Education level				Work experience						∑	
		Univer. d.		Assoc. d.		< 10		10 – 20		> 20			
		f	%	f	%	f	%	f	%	f	%	f	%
Three levels of individualization	Yes	65	75.58	24	85.71	23	74.19	37	77.08	29	82.86	89	78.07
	No	21	24.42	4	14.29	8	25.81	11	22.92	6	17.14	25	21.93
Use of worksheets	Yes	72	83.72	26	92.86	27	87.10	40	83.33	31	88.57	98	85.96
	No	14	16.28	2	7.14	4	12.90	8	16.67	4	11.43	16	14.04
Computer-assisted instruction	Yes	79	91.86	24	85.71	28	90.32	43	89.58	32	91.43	103	90.35
	No	7	7.14	4	14.29	3	9.68	5	10.42	3	8.57	11	9.65
Problem-based instruction	Yes	86	100	28	100	31	100	48	100	35	100	114	100.0
	No	0	0	0	0	0	0	0	0	0	0	0	0.00
Programmed instruction	Yes	80	93.02	26	92.86	29	93.55	45	93.75	32	91.43	106	92.98
	No	6	6.98	2	7.14	2	6.45	3	6.25	3	8.57	8	7.02

Based on the results obtained, we can conclude that teachers have positively evaluated the structure of designed models for the types of individualized instruction in question, with the lowest validity percentage pertaining to the three levels of individualization approach (78.07%), while the highest validity percentage pertains to problem-based instruction where all 114 teachers (100%) positively assessed the proposed model. A statistically significant difference at the significance level of 0.05 was observed only in the case of the model designed for the use of worksheets, specifically between the teachers who positively evaluated the given model, in relation to the education level variable, where $t(97) = 2.00$, $p = 0.0483$, in favour of those teachers with associate degree.

4. Discussion

On the one hand, teachers believe that the designed models are suitable to be used for the proposed types of individualized instruction. They are also aware that it is necessary to use individualized instruction approach in the initial mathematics teaching.

This claim is also supported with the fact that they believed that the reasons offered supporting the adaptation and adjustment of the teaching process to different learning abilities of students, relating to both student activity and teacher activity, are valid, and that this is necessary or desirable to be done. On the other hand, the results of the research indicate that most teachers only sometimes choose to organise their lessons using some type of individualized instruction. They often use worksheets, while they very rarely apply problem-based instruction. This claim is supported with the results that show which type of individualized instruction deliver the best outcome – only 7.02% of teachers gave priority to problem-based instruction, compared to all other types of individualized instruction. The majority of teachers (41.23%) have opted for the three levels of individualisation approach, followed by computer-assisted instruction and use of worksheets, while 10.53% of surveyed teachers chose programmed instruction. Considering the above and based on the results obtained relating to types of lessons that certain forms of individualized instruction approach are suitable for, we can see that the forms of individualized instruction which most teachers favoured (three levels of individualization and use of worksheets) are mostly used in revision, practice and systematization lessons. When it comes to the lessons where new mathematical concepts are presented, as well as mathematical facts, algorithms, rules, etc., mainly traditional teaching methods continue to be used. Why is this the case?

The results obtained indicate that one of the reasons for this is the fact that teachers believe they are still not sufficiently skilled to apply individualized instruction. Some of the reasons why they do not choose to use this approach are the following: teaching mathematics by using some type of individualized instruction takes much more time (which they lack due to curriculum overload with content that students need to master during the school year), lesson planning for individualized lessons is much more complex. An additional reason is their belief that mathematical concepts are not too suitable to be taught using individualized instruction approach – only 21.05% of them think they are suitable, while there are some who believe mathematical concepts are not suitable to be taught using this approach at all.

Given that the results of many studies dealing with the efficiency of individualized instruction and its types (some of which were mentioned in the introduction section of this paper), confirmed their undeniable advantages compared to traditional instruction, it is very unfortunate that teachers rarely use individualized instruction and still choose traditional approach in initial teaching period. Furthermore, teachers' opinions do not generally differ, both in relation to their education level and in relation to their years of work experience, as confirmed by the research.

5. Conclusion

Models designed to be used for teaching of mathematics by applying individualized instruction approach were developed based on contemporary concepts, which is reflected in the following: goals and objectives are operationalized so that students themselves can also assess whether they have achieved them; each model contains a structured lesson plan where students' and teachers' activities for each phase of the lesson are specified, while it also contains all didactic components relevant to the model; individualization and differentiation were done taking into account course content and operational objectives; the operationalization of the structured lesson plan per phase was provided, depending on the type of individualized instruction the model related to; each model also contains feedback about students' success or failure in acquiring knowledge, skills and habits; criteria were also given which were used to choose questions and exercises based on difficulty level, which were also aligned with the taxonomic model of teaching goals and objectives. The above claims are supported with the research results relating to teachers' perceptions and opinions, where they claimed that the models designed are suitable to be used to teach course content to which they relate, that these models are linked to previous knowledge and experience of students, that they affect the discovery of essential relationships and links among the concepts to which they relate, that they affect the development of students' thought process, that is, the quality of the acquired knowledge in terms of its durability, the ability to apply it in real life situations and build critical and creative thinking, as well as that they positively affect student motivation to learn mathematics.

Furthermore, based on the results obtained relating to the possibility of applying individualized instruction in initial mathematics lessons, teachers' opinions are mostly aligned with regard to the level of education and work experience variable, thus, the following can be concluded: Teachers believe that mathematics course content is partially suitable to be studied using individualized instruction, the majority of these teachers have less than 10 years of work experience; three levels of individualization approach deliver better learning outcomes than other types of individualized instruction;

Teachers mostly use programmed instruction in presentation-type lessons, while worksheets are primarily used in revision, practice and systematization lessons; problem-based instruction is the most seldom used, and there is only a handful of teachers who believe that problem-based instruction delivers the best learning outcomes, and as many as 42.98% of teachers prefer not to use this type of instruction – the majority of which have university degree and less than 20 years of work experience; teachers believe that the three levels of individualization approach and worksheets are mostly suitable for revision lessons, while teacher presentation, problem-based and programmed instructions are preferable for new content introduction lessons; most of them think that they are only partly skilled and qualified to apply some form of individualized instruction, with majority of them having less than 20 years' work experience. The reasons offered supporting the adaptation and adjustment of the teaching process to different learning abilities of students are: firstly, intrinsic motivation in students in terms of their needs, desires, interests and curiosity to learn something, focus of the teaching process on developmental, problem-oriented, research activities, which encourage student creativity, while developing students logical reasoning, building self-confidence in overcoming obstacles, and teacher satisfaction due to greater professional success are seen as desirable reasons to support individualization. Teachers opinions are divided when it comes to the necessity to structure course material based on students' abilities, prior knowledge, experiences and interests, pace of learning, attitude towards learning, readiness to learn (as one of the reasons to apply individualized instruction).

To conclude, we can say that teachers are aware of the importance of individualized instruction, they are familiar with the characteristics of some of its types, with its positive effects on students' achievements, as indicated by numerous studies in this field (see, Slavin & Karweit, 1985, Connor at all, 2018; Barrow, Markman, & Rouse, 2009; Cardona, 2002; Ronshausen, 2015, Webel, Krupa, & McManus, 2015, etc.), however, this type of instruction is still not applied as much as it should. One of the reasons for it is the lack of proper practical models for individualized instruction. This is why we hope that this particular paper will help change the approach to mathematics teaching, primarily course material presentation, and that it will trigger a more efficient learning process individualization, etc.

References

Bakovljev, M. (1998). *Didaktika*. Beograd: Naučna knjiga.

Barrow L., Markman, L., & Rouse, C. E. (2009). Technology's edge: The educational benefits of computer-aided instruction. *American Economic Journal: Economic Policy,* 1 (2009), 52-74.

Bloom, B., Englehart, M., Furst, E., Hill, W., & Krathwoll, D. (1956). *Taxonomy of educational objectives: The classification of educational goals, Handbook I: Cognitive domain.* New York, Toronto: Longman, Green and Co.

Bogdanović, S., & Malinović-Jovanović, N.(2009). Taksonomski model i stepen ostvarenosti zadataka nastave matematike u III razredu osnovne škole. *Pedagogija*, 64 (4), 618-632.

Cardona, M. C. (2002). Adapting instruction to address individual and group educationalneeds in math. *Journal of Research in Special Educational Needs*,2(1),1-16.

Collins English Dictionary. Retrieved April 18, 2018 from https://www.collinsdictionary.com/dictionary/english/individualized-instruction

Dell'Olio, J., & Donk, T. (2007). *Models of teaching: Connecting student learning with standards.* Thousand Oaks, CA: Sage Publications.

Connor, C., Mazzocco, M., Kurz, T., Crowe, E., Tighe, E., Wood, T., & Morrison, F. (2018). Using assessment to individualize early mathematics instruction. *Journal of School Psychology*, 66(2018), 97-113. http://dx.doi.org/10.1016/j.jsp.2017.04.005.

Gage, N. L., & Berliner, D. (1975). *Educational Psychology*. Rand McNally College Publ. Comp.

Gibbons, M. (1970). What is individualized instruction? *Interchange*, 1(2), 28-52. https://doi.org/10.1007/BF02214857

Heathers, G. (1977). Definition of Individualized Instruction. *Educational Leadership*, 342-345.

Ilić, M. (1984). *Diferencijalna razredna nastava*. Beograd: Prosvetni pregled.

Jukić, S., Lazarević, Ž., & Vučković, V. (2002). *Didaktika – izbor tekstova*. Jagodina: Učiteljski fakultet.

Kirby, R., & Radford, J. (1976). *Individual Differences*. London, UK: Methuen young books.

Krathwohl, D. R. (2002): A Revision of Bloom's Taxonomy: An Overview. *Theory Into Practice*, 41(4), 212-218.

Kundačina M. (2001). *Diferencijacija i individualizacija nastave – osnovna škola budućnosti*. Sombor: Učiteljski fakultet.

Laketa N., &Vasilijević, D. (2006). *Osnove didaktike*. Užice: Učiteljski fakultet.

Lazarević, Ž. (1996). *Savremena škola i obrazovanje učitelja*. Jagodina: Učiteljski fakultet.

Malešević, D. (2012). Nova vrsta modela: Heurističko-algoritamski model. *Obrazovna tehnologija*, 3/2012, 279-286.

Mandić P. (1987). *Inovacije u nastavi*. Sarajevo: NTKRO Svjetlost, Zavod za udžbenike i nastavna sredstva.

Milijević, S. (2003). *Interaktivna nastava matematike*. Banja Luka: Društvo pedagoga Republike Srpske.

Miljević, M. (2007). *Metodologija naučnog rada*. Pale: Filozofski fakultet - Univerzitet u istočnom Sarajevu.

Nastavni program za prvi, drugi, treći i četvrti razred osnovnog obrazovanja i vaspitanja *[The Curriculum for First, Second, Third and Fourth Grade of Primary Education]*. „Službeni glasnik RS – Prosvetni glasnik", br. 10/04, 20/04, 1/05, 3/06, 15/06, 2/08, 7/10, 3/11, 7/11, 1/13, 4/13, 5/14 i 11/14.

Petrović, N. (2001). Modelsko-problemski pristup u diferenciranju i individualizovanju početne nastave matematike. U N. Petrović i M. Lipovac (Ur.) *Diferencijacija i individualizacija nastave – osnova škole budućnosti*. Sombor: Učiteljski fakultet.

Poljak, V. (1990). *Didaktika*. Zagreb: Školska knjiga.

Ronshausen, N. (2015). The Effect on Mathematics Achievement of Programed Tutoring as a Method of Individualized, One-to-One Instruction. *The Journal of Experimental Education*, 47(4), 268-276, DOI: 10.1080/00220973.1979.11011692

Sayre, J. (1975). *Individualized Instruction: A New Force in Teacher Education*.

Slavin, R.E., &Karweit, N.L. (1985). Effects of whole-class, ability grouped, and individualized instruction on mathematics achievement. *American Educational Research Journal*, 22(3), 351-367. DOI: 10.3102/00028312022003351

Webel, C., Krupa, E., & McManus, J. (2015). Benny goes to college: Is the "Math Emporium" reinventing Individually Prescribed Instruction? *MathAMATYC Educator*, 6(3), 4-13.