Support to Pupils with Learning Difficulties in Mathematics

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Abstract

In this paper we present a model of assistance to pupils with learning difficulties in mathematics - Implementation of modifications for pupils with learning difficulties in mathematics (hereinafter – the model LDMAT) and LDMAT model’s contribution to the teachers’ competence to implement the support measures to pupils with learning difficulties in terms of the empirical study. The conceptual platform of the model LDMAT is based on the following principles: giving sense to mathematical knowledge, instruction as mutual activity of pupils and teachers, the principle of participation. The results of the study have shown that LDMAT model’s contribution to the qualification of teachers to assist pupils with learning difficulties is very positive and represents a significant contribution to the improvement of teaching practices in overcoming learning difficulties in mathematics. Among the teachers, the model LDMAT was evaluated the highest in the field of selection, planning and use of appropriate didactic tools; they also highlighted the key factors for raising pupils’ learning achievements: an individualized approach, promotion of the use of multi-sensory learning, timely support, cooperation with parents, encouragement for continuous work, discussion between teachers, pupils and parents, early involvement of pupils and parents in the preparation of the assistance plan, encouraging pupils to self-learning, etc.

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1. Introduction

Teacher’s support to pupils with learning difficulties in mathematics is closely associated with his views and conceptions of the importance of certain mathematical contents as well as with his didactic and methodical skills to work with pupils with learning difficulties, with the understanding of his and pupil’s role in the classroom. In order to implement assistance measures to pupils with learning difficulties in mathematics we have created a model

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Implementation of modifications for pupils with learning difficulties in mathematics - model LDMAT (Žakelj, 2012).

The conceptual starting point of the model is based on the findings that the anxiety of pupils is caused by five factors (Shieelda, 2005, v: Kavkler 2010): pupils’ and teachers’ views on mathematics, curriculum, teaching strategies, classroom culture and assessment. With respect to these findings, the conceptual platform of the model LDMAT (Žakelj, 2012) is thus based on the following principles:

- **making sense of mathematical knowledge** as a consideration about which mathematical concepts or procedures are necessary that every pupil acquire them, and how to proceed if a pupil doesn’t achieve certain goals and contents;

- instruction as mutual activity of pupils and teachers based on mutual liability;

- **the principle of participation** signifies a joint creation of education and a joint creation of mathematics and to respect pupils’ cognitive, social and emotional needs through this process. In practice joint creation of mathematics means to express mathematical thoughts, to express knowledge and understanding of mathematical concepts, procedures and relationships among them. Furthermore, joint creation signifies also taking into consideration the pupils’ needs for social and emotional aspects.

Specific areas of the model LDMAT are defined in two key substantive pillars: the first defines the elements of a supportive and safe (learning) environment, and the other provides methodical steps for implementation of adjustments to pupils with learning difficulties in mathematics. Stimulating and safe learning environment is based on constructive cooperation of pupils, professional staff and parents. This is an environment where all pupils have the opportunity and ability to co-create math lessons. Stimulating and safe learning environment is an environment that co-create professionals who have extensive knowledge of cognitive, social and emotional characteristics of pupils, who are familiar with the characteristics of pupils with learning difficulties and with the approaches for the implementation of adaptations for pupils with learning difficulties as well, who are guided by the principle of participation, the involvement of all pupils in class. Meaningful participation is a fundamental experience that we all need for living in this world. Čačinović Vogrinčič (2008) and Šugman Bohinc (2011) note in their researches that the experience of cooperation is more efficient and more beautiful path to gain knowledge as it is a competition of all against all. The concept of co-creation of learning and support in the working process greatly changes the usual way of assisting pupils with learning difficulties. **Methodical steps of the model LDMAT** are circularly connected, and they spirally upgrade. Under the methodical steps we understand: continuous and systematic monitoring of pupil’s progress (diagnostic, formative, summative), identification of learning difficulties, planning and implementation of strategies/measures of assistance, the reflection of the teacher and pupil, the evaluation of pupil’s progress, and the evaluation of the effectiveness of assistance. The cycle spirally upgrades and continues. While planning activities within classes we also involve pupils, we take into consideration strong areas of individual pupils, their interests and motivation styles. We plan the role of school counselling service and parents’ participation. Within the elements of planning didactic units from the perspective of learning difficulties treatment we determine the following: psychological aspect (characteristic of pupils, motivation …); general and operational objectives of the didactic unit (level of necessity of particular aims and contents from the perspective of providing help to pupils with learning difficulties); contents (extent, content depth); necessary prior knowledge for the acquisition of new objectives and contents (level of necessity for particular objectives and contents from the perspective of assistance to pupils with learning difficulties); ways of indentifying learning difficulties; assistance measures in order to reach objectives in case of possible difficulties (adjusted didactic approaches, didactic materials, help provided by the school supportive service); monitoring pupils advancement (diagnostically, formatively, sumatively); the ways of producing and applying didactic requisites/materials (the purpose of didactic requisites; who produces didactic requisites/materials; when, what for and for how long pupils use the requisites …); home works (extent, purpose, types of home works; home works as a means of the promotion of independence, creativity, responsibility; home works as the tool for the promotion of positive attitude to school, to knowledge, to school obligations); ways of pupils’ inclusion into joint creation of instruction; reflexion of teachers and pupils (questions, possible guideline elements for records). For the effective implementation of the model UTMAT you need to strictly implement all the steps and support measures. Two most important conceptual characteristics of the model are **progressivity** and **flexibility**. Learning and teaching, that follow the stages of cognitive development, represent the transition from specific representations of concepts to abstract conceptualization. The key to successful acquisition of mathematical concepts is the **representations of concepts** which can be specific, graphic, symbolic or abstract. Chapman (2001, in Hodnik Čadež, 2003) emphasizes that representations allow pupils to communicate in mathematical way, to model and interpret real, social and mathematical context, and to explore and interpret the
meanings of mathematical concepts, relations and procedures. Representations, or better, the ways how pupil handle them allow also the monitoring and evaluation of pupil’s progression in mathematical knowledge. Bruner (1966) took the sequence of representations in addressing mathematical concepts (first inactive, then iconic and in the end symbolic) to define the progress od pupil’s development of mathematical concepts. Recent studies show that relations between representations of certain mathematical concept (Chapman, 2001) and flexible transitions between different representations are more significant then the order of representations. Besides structured and systematically guided teaching, also the application of learning aids/requisites is indispensable for pupils with learning difficulties. Quite often pupils with learning difficulties can acquire mathematical concepts and procedures only with the help of appropriate support. Learning requisites have to be practically applicable; they have to serve pupils as support for the illustration of concepts and relationships, as help in understanding, as support in learning process, as a reminder with the steps for solving, etc. (Žakelj, 2013). In addition to the fact that requisites serve pupils as cognitive tools, they may provide them with a feeling of safety or serve as a motivation tool. When taking decisions on teaching aids we take into account pupils’ needs; we teach them how to apply them and also how to produce them by themselves, e.g., the card with formula helping to recall; square pattern paper for addition/subtraction because of correct subscribing; solving procedure written in steps, made by pupils themselves with expressions that they understand; table with units; cards with multiplication table or multiples; table with multiples for learning basic calculating operations; coins, tokens, plates for illustrating numbers, for counting forwards, backwards, by one, by two, complement numbers, add numbers, subtract, multiply; various proposal; pocket calculator; the use of reminders, etc. It is also vital that we consider carefully when pupils apply learning aids/requisites and when those requisites are meaningful and effective. Pocket calculator for example may be effective when applied for calculating percentages if an individual does not master well calculation procedures, but not in cases when he/she does not understand the concept of percentage.

2. Methods

The core research question was to determine in which extent the implementation of the model LDMAT contributes to teachers’ competence for the implementation of support to pupils with learning difficulties in mathematics. The sample included 118 professional school staff; 80 od these were primary school teachers, and the rest 38 mathematics teachers. We used a questionnaire with five point scale responses, from 1 – it didn’t contributed at all to 5 – it contributed very much, to assess the contribution of the model LDMAT to teacher’s competence to implement of assistance measures to pupils with learning difficulties in mathematics. The data from the survey questionnaires were statistically processed according to the purposes and objectives of the study by applying the tool R for Windows. Considering the data features we applied the following methods: Frequency classification for the display of the answers to closed questions, Mann Whitney’s test of ranks sum in order to assess the differences between the two groups of teachers: classroom teachers and teachers of mathematics.

3. Results and discussion

Empirical results of the model LDMAT contribution to the teachers’ competence to implement the support measures to pupils with learning difficulties are presented in Table 1.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>R</th>
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<tbody>
<tr>
<td>class t.</td>
<td>80</td>
<td>3,1</td>
<td>1,0</td>
<td>57,8</td>
<td>1384,5</td>
<td>0,41</td>
</tr>
<tr>
<td>math t.</td>
<td>38</td>
<td>3,3</td>
<td>1,0</td>
<td>63,1</td>
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<tr>
<td>class t.</td>
<td>80</td>
<td>3,3</td>
<td>1,0</td>
<td>55,5</td>
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<td>0,05</td>
</tr>
<tr>
<td>math t.</td>
<td>38</td>
<td>3,6</td>
<td>0,8</td>
<td>67,9</td>
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</tr>
<tr>
<td>class t.</td>
<td>78</td>
<td>3,2</td>
<td>1,0</td>
<td>54,5</td>
<td>1171,5</td>
<td>0,14</td>
</tr>
<tr>
<td>math t.</td>
<td>36</td>
<td>3,6</td>
<td>1,0</td>
<td>64,0</td>
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</tr>
<tr>
<td>class t.</td>
<td>80</td>
<td>3,7</td>
<td>1,1</td>
<td>58,6</td>
<td>1444</td>
<td>0,65</td>
</tr>
<tr>
<td>math t.</td>
<td>38</td>
<td>4,0</td>
<td>0,8</td>
<td>62,5</td>
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</tbody>
</table>
UTMAT model’s contribution to teachers’ capability to choose and plan suitable didactic tools (math teachers: M = 4.0, class teachers: M = 3.7) was ranked the highest among class and math teachers measures in the field of detection of learning difficulties and planning assistance and was followed by: identifying and identification learning difficulties (math teachers: M = 3.6, class teachers: M = 3.3), adapting preparations for instruction (math teachers: M = 3.6, class teachers: M = 3.2), identifying previous knowledge of pupils with learning difficulties in detecting and identifying learning difficulties (math teachers: M = 3.3, class teachers: M = 3.1), and communication with pupils who have learning difficulties (math teachers: M = 3.7, class teachers: M = 3.1). LDMAT model's contribution to teachers' competence in giving opportunity to use adequate didactic tools (class teachers: M = 3.9; math teachers: M = 3.8) and in adjustment of the methods for evaluation and assessment (math teachers: M = 3.7, class teachers: M = 3.5) were also ranked the highest in the field of implementation of assistance methods. There were followed by: adapting learning materials (math teachers: M = 3.6, class teachers: M = 3.4), adapting delivery of learning content (math teachers: M = 3.6, class teachers: M = 3.3), adapting didactic approaches to achieve the basic standards of knowledge (class teachers: M = 3.4, math teachers: M = 3.7), adapting didactic approaches to achieve the minimum standards of knowledge (class teachers: M = 3.4, math teachers: M = 3.8), implementation of internal differentiation (class teachers: M = 3.2, math teachers: M = 3.3). Given that among teachers the contribution of the model LDMAT to the selection, design and use of appropriate didactic tools was rated the highest, we can conclude that teachers also identified and assessed that experiential learning, practical activities, authentic tasks, appropriate selection and use of didactic tools represent very important support to pupils with learning difficulties in mathematics. Often happens that pupils are enabled to build knowledge with understanding only with use of didactic tools. Opportunities for greater impact are increased if pupils continue with the selected school activities at home, and with the assistance and cooperation of the parents. The results of the research indicate that this is also a segment, to which we need to pay more attention and development work. In the free responses, teachers highlighted the key factors for raising pupils’ learning achievements: an individualized approach, promotion of the use of multi-sensory learning,
verbalization of procedures, timely support, permanent home work and cooperation with parents, motivation, use of appropriate didactic tools, encouragement for continuous work, discussion between teachers, pupils and parents, the pupil and parent involvement in the preparation of the assistance plan, encouraging pupils to self-learning, etc. The results of empirical study suggests that the contribution of the model LDMAT to the competence of teachers for teaching pupils with learning difficulties in mathematics is positive and represents a significant move towards the improvement of teaching practices in overcoming learning difficulties in mathematics. Nevertheless, it is necessary to draw attention to the segments where the effects are not as convincing: communication with parents of pupils who have learning difficulties, anticipation of learning difficulties, internal differentiation, and identification of pupils' previous knowledge in detecting and identifying learning difficulties. The study results suggest that we should pay more attention to the above listed teaching processes, especially in the education of teachers. The teacher should know or take into consideration the ways how pupil constructs his knowledge that will enable him to better understand the basic terms and concepts. The structure of existing knowledge has a significant impact on learning processes. A very important factor that affects learning, is previous knowledge of the learner. If certain concepts, that are important for the acquisition of new knowledge, do not already exist in the mind of the learner, then every new fact can only be learned by heart (Žakelj, 2004). Piciga (1995), also determined that understanding of pupils' thinking skills and his previous knowledge are the key factors for the effective learning of new content. In addition to the development phase of the pupil, one of the most important factors when learning new mathematical concepts (Rugelj, 1996) is a pupil's previous knowledge, which teacher should take as the starting point when he submits new concepts. Authors of the study (Zuljan et al., 2012) also identified that internal differentiation, which would allow the integration of different teaching and learning approaches, tailored to individual pupils or groups of pupils, is under-utilized. After the analysis of observed lessons Valenčič Zuljan et al. (2012), also noted that there is noticeably more cooperative learning, problem class, associated with realistic situations, guided research, and discussions, in the third level group than in the first or second level group, and that in heterogeneous learning groups internal differentiation, which would allow the integration of these approaches to teaching and learning, was significantly under-utilized. Furthermore, the results of the survey in the background also highlighted the importance of changing teacher’s attitudes when teaching practices change. The results showed that teachers rated the highest those items of the LDMAT model, in which they had more previous experiences, for example the use of didactic tools, approaches for the evaluation and assessment, but they rated the contribution of the model to communication with parents the lowest. It is also possible that some segments of the model sounded less compelling, or that teachers don’t pay enough attention to them. Only processes that involve the teacher in education, research, implementation of innovations and evaluation of his own practice may have a positive impact on changing teacher’s attitudes and behavior. This process is time consuming and subject to change only through person’s own experience. In the survey Facing schools with innovative challenges the researchers Cankar, Deutsch, Setnikar Cankar (2013) founded out that teachers, who were involved in the implementation of innovations and in the development work, significantly distinguished from their colleagues in some important starting points. Teachers, involved in the development and implementation of innovations, were, on one hand, more critical to changes, but on the other they also accepted pupil's ideas in the classroom to a greater extent, they often use ICT, involve pupils in project work, as teachers that have not been involved in the process (ibid.). The results showed that at the majority of the items math teachers evaluated the contribution of the model LDMAT to their competence for implementation of the assistance measures a little higher as class teachers, although the differences were not statistically significant. Some other researches on the teachers’ competence show a similar picture. The authors Žakelj and Valenčič Zuljan (2014) discovered that class teachers estimated their ability to detect learning difficulties and to plan assistance measures significantly higher as teachers of mathematics. According to this survey we could conclude that math teachers estimated their own competence lower at the outset, so therefore they recognized the model as an opportunity for further education. It is also possible that math teachers are somewhat more critical to their knowledge and skills and are only later satisfied with their existing knowledge. It is also true that the forms of assistance, such as adjustment of the methods for consolidating the knowledge, adjustment of the learning environment (seating order, quiet corner, etc.), adjustment of courseware, facilitation and use of appropriate didactic tools (calculator, numeric tape, etc.), are from didactic reasons more often used at the class level, so class teachers have some more experience with them.
4. Conclusions

The results show that the contribution of the model LDMAT to the competence of teachers to support pupils with learning difficulties is very positive and represents a significant contribution to the improvement of teaching practices at overcoming of learning difficulties in mathematics. Good professional relationship between teachers, pupils and parents is the most important factor for successful overcoming of learning difficulties. Cooperation between teachers who teach the pupil, and empathic and appropriately "patient" relationship between the teacher and the pupil are important as well. Teacher also needs to encourage the pupil to involve in the community when organizing pupils’ mutual help, and to encourage peer collaboration among pupils, etc. Educated, independent, competent and autonomous teacher that is emphatic for the learner is one of the key factors in the school environment, which significantly affects the performance of the pupil. Darling Hammond (2005, adapted from the European Commission, 2007) even points out that these effects may have even much larger impact than school organization and leadership or financial conditions. Based on the results of the survey we suggest continued research and development work in the field of working with pupils with learning difficulties in mathematics and further education of teachers. We would like to continue with the detection and elimination of the causes of learning difficulties of pupils, the adaptation of teaching methods to enhance responsibility and motivation for learning, and the enhancement of the formative assessment and timely response to the needs of pupils, assertion of self-regulation skills, and learning and metacognitive strategies that experts classify as the most fundamental skills of the 21st century (Instance, Dumont, et al., 2013).

References