

Amalija Žakelj*

University of Primorska, Faculty of Education, Koper, Slovenia

Darjo Felda*

University of Primorska, Faculty of Education, Koper, Slovenia

Mara Cotič*

University of Primorska, Faculty of Education, Koper, Slovenia

ASSISTANCE TO PUPILS WITH LEARNING DIFFICULTIES IN MATHEMATICS

Abstract: In the paper we are going to discuss in what ways the teacher ought to educate pupils who experience different difficulties in learning mathematics. The conduct of teachers in planning and implementing the learning process from the perspective of assistance to pupils with learning difficulties are closely related with their views and notions about the relevance of individual mathematical contents as well as with their concepts of teaching, knowledge, teacher's and pupil's role in the classroom.

A conceptual design of the model has been created, which is based on the following premises of quality learning and teaching for pupils with learning difficulties: Making sense of mathematical knowledge from the perspective of providing assistance to pupils with learning difficulties; Education as a mutual activity of the learner and the teacher (the principle of mutual responsibility); and The principle of participation of the pupil in the planning, implementation, and evaluation of learning and teaching.

Keywords: *learning mathematics, responsibility, active participation.*

INTRODUCTION

In the modern-day organisation of the school system that abandons the entrenched approaches and exceeds the customary moulds, the school opens up to new paradigms, to a new social agreement that will allow a wider circle of people to feel more motivated for life and work. In this context modernisation of teaching and learning, primarily of methods and forms of work, means the creative aspect of the development and of the structure of the school system. To the basic human rights

* amalija.zakelj@pef.upr.si

* darjo.felda@pef.upr.si

* mara.cotic@pef.upr.si

also the right to be different belongs – the right, then, to be a human with special needs and simultaneously an individual, human as an absolute value with personal dignity. In the area of the topic of children and adolescents with special needs, continuous searching for better ways to protect human rights and the concept of integration have been assuming universal dimensions. Educational legislation also classifies learners with specific learning disabilities that include a diverse group of disorders characterised by having a neurophysiological background as belonging to children with special needs. With such children the teacher must lead the education procedure in a manner that provides sense to mathematical knowledge and presents learning and teaching as a mutual activity of the learner and the teacher, with the learner co-creating the teaching and learning of mathematics (the principle of participation) (Žakelj & Grmek, 2013).

Providing sense to mathematical knowledge

The teacher must first provide the learners who have difficulties acquiring mathematics with the sense to mathematical knowledge. *From the perspective of support to learners with learning disabilities*, providing sense to mathematical knowledge means deliberation what mathematical concepts and procedures must necessarily be acquired by every learner. The deliberation is important what to do if a learner fails to attain certain goals and contents. The decision depends on the relevance of the contents for the further building of knowledge, on its applicability in life situations, on the type of learning disorder, the peculiarities of each learner, etc.

Teaching and learning as learner’s and teacher’s mutual activity

Teaching and learning as learner’s and teacher’s mutual activity, where learning takes place as learner’s and teacher’s activity, is the principle that means understanding their relationship as mutual responsibility of both for learner’s success and overcoming learning disabilities. Learner’s learning disabilities are learner’s and teacher’s shared ‘problem’.

THE PRINCIPLE OF PARTICIPATION

The principle of participation means that the learner ‘co-creates learning and mathematics’, that he is as actively involved in the process of planning, implementing, and evaluating the learning process as possible. Above all, shaping teaching that takes account of learner’s needs in cognitive, social, and emotional area is important. Learner’s co-creation of mathematics means expression of mathematical thought, expression of mathematical concepts, procedures, and their mutual relationships. E.g.: including the learner into the planning of work; the teacher and the learner daily make arrangements about the learner’s homework; the learner sets his own objectives and co-creates the network of assistants.

STIMULATING AND SAFE (LEARNING) ENVIRONMENT AND METHODOLOGICAL STEPS FOR THE IMPLEMENTATION OF ADJUSTMENTS TO PUPILS WITH LEARNING DISABILITIES IN MATHEMATICS

The learner who suffers difficulties in the learning of mathematics must be offered *stimulating and safe (learning) environment and didactic steps that are adjusted to learners with learning disabilities in mathematics.*

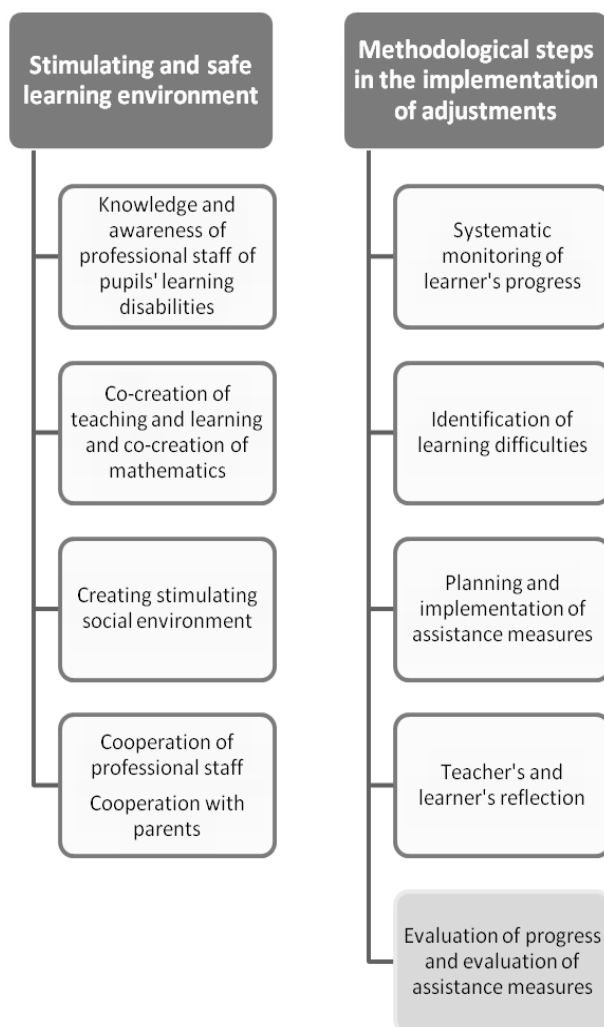


Figure 1. Model of implementation of adjustments to learners with learning disabilities in mathematics (Žakelj, 2012)

STIMULATING AND SAFE LEARNING ENVIRONMENT

Stimulating and safe learning environment can be created by informed teachers and other professional staff who are familiar with both the characteristics of pupils with learning disabilities and with the approaches for the implementation of adjustments to pupils with learning disabilities, are guided by the principle of participation, which means that they seek to involve pupils as actively as possible in learning and teaching (co-creating instruction and mathematics), who seek to build stimulating environment – a class climate that is designed to respect diversity and shared learning, and a school climate based on the professional development of teachers and of other professional staff.

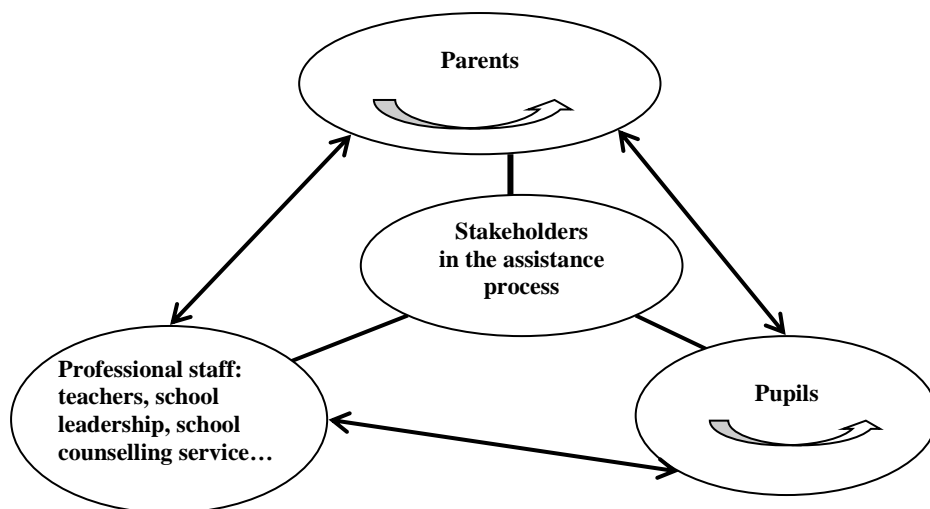


Figure 2. Stakeholders in the process of assistance to learners with learning disabilities

Good professional relationships between the teacher, the learner, and the parents are crucial to successfully cope with learning disabilities. Cooperation among the teachers who teach the learner is important as well as emphatic and appropriately ‘patient’ relationship of the teachers toward the learner. Also important is the teacher’s endeavour to include the learner into the community in the organisation of pupils’ mutual assistance, of peer cooperation among pupils, etc.

Cooperation is critically important for the creation of stimulating and safe learning environment. The cooperation takes place among various groups (teachers and learners, teachers and school leadership, teachers and parents, teachers and school counselling service, etc.) as well as within the groups (among the teachers,

among the pupils, etc.). Collegiate class observation, critical friendship among teachers, exchange of teaching aids and of experience among teachers, school leadership, school counselling service, special pedagogues/defectologists/counselling services are important. It is also extremely important to appropriately include the parents of pupils with learning disabilities and that from the very beginning. Cooperation among pupils is best implemented in the models of tutoring and peer learning, of quality work organised in pairs, and of well organised cooperative learning.

Since carefully planned and appropriately guided cooperative learning is an important factor of creating stimulating and safe learning environment with numerous opportunities for quality learning of pupils with learning disabilities, it will be presented a little more into detail below.

Johnson & Johnson (1999) cite five elements that determine the actual cooperative learning groups: direct interaction, positive interdependence, the responsibility of the individual, collaborative skills, group processing.

Cooperative learning provides learners the social support they need in their learning. If we wish cooperative learning to be efficient, groups must be cooperative – all the members must take part. This requires careful deliberation by the teacher how to set up the working group, where to include pupils with learning disabilities, how to make sure they will be appropriately involved in the learning process. It is important for the teacher to be aware that cooperation among pupils is not automatic and self-assumed; that it is rather a gradual and planned learning process.

Due to different views, disagreements when working in cooperative groups learners reiterate their justifications and explanations several times and in different ways (Peklaj, 2001). Repetition, which in individual learning is the most difficult, can thus be simply assured. The learners are provided opportunities to compare their knowledge with the knowledge of others and to get feedback on what they already know. The diversity of learners in the group can be a source of creativity within it. Every pupil in the group contributes his or her own different ideas, new views of solving problems or a new strategy. Pupils often understand their peers' explanations better than they do the teacher's, because they can be closer to their level and way of thinking than the teacher's explanation. In cooperative groups there are lots of possibilities for peers to explain things that are not clear at the level which the pupils can understand better. They can help a school mate by describing the tasks, with comments on their similarities with preceding tasks, by explaining concrete steps, with model presentations of ideal thinking, by diverting the focus showing where there is an error in the thinking, where something seems to be illogical. They present the task in a different way, e.g., with a sketch, not just verbally.

Group work can create cognitive conflict and imbalance that leads the individual to verify his own understanding and to trying new ideas. According to

Vygotsky (1978) social interaction in learning is important because higher mental functions such as reasoning, understanding, and critical thinking originate from social interactions that individuals internalise later on. Before being able to solve mental tasks on their own, children can solve them with social support. From the point of view of pupils with learning disabilities it is of crucial importance that the teacher ensures the cognitive conflict is not too great, as this might lead to pupils being subject to further failure or deterioration of their social status and acceptance in the group.

The effects of cooperative learning vary depending on what is really going on in practice. If barely a few pupils in the group assume the responsibility, they will learn, while the others will not. The pupils who ask questions, get answers, and try to arrive at explanations, will more likely learn than those whose questions remain unuttered and unanswered. In fact, there is evidence that proves that the more pupils elaborate and thoughtfully explain to others, the more they learn themselves. Good explanation is even more important for learning than for accepting the explanation (Webb & Palimar, 1996). If we wish to explain something, we must organise the information, translate it into our own words and invent examples and analogies (thus linking the information with what we already know) and verify our understanding by answering questions. These are excellent learning strategies. A number of studies have been carried out to determine in what ways cooperative learning affects the learning outcome. The Johnson brothers and associates (Peklaj, 2001) found that cooperation leads to better outcomes than competition. Cooperation was more successful in all areas and in all age groups and with various types of tasks (filling in, learning new concepts, solving problems), the advantage of cooperative learning being greater in smaller groups. Slavin's (Peklaj, 2001) review study has shown that to obtain better outcomes in cooperative learning clear group goals are important, which within the group are attained with group rewards and clear individual's responsibility for the contribution in the group.

METHODOLOGICAL STEPS IN THE IMPLEMENTATION OF ADJUSTMENTS

Besides stimulating and safe learning outcomes the methodological steps in the implementation of adjustments are important for the work with pupils with learning disabilities.

Methodological steps are circularly connected and are spirally upgraded:

1. ongoing and systematic monitoring of pupil progress (diagnostic, formative, summative), *the findings or outcomes lead to*;
2. the identification of learning disabilities;
3. planning strategies/measures of assistance;

4. implementation of strategies/measures of assistance *to the concluding phase of the first circle, which is;*

5. the teacher’s and the learner’s reflection and evaluation of learner’s progress and the evaluation of the efficacy of the assistance.

The cycle is spirally upgraded and it continues.

The learner’s cocreation of learning and teaching and of mathematics is a component of all the steps and it takes place from planning to implementation and evaluation. Involving the pupils in the process of planning classroom activities allows us, inter alia, to learn the pupil’s strong areas, interests, motivation and thus being able to carry out learning individualisation in the classroom more appropriately.

The methodological steps get defined in the plan of dealing with learning disabilities. *The plan of dealing with learning disabilities* is a component of the global planning of teaching, or of stage in the implementation. It contains the elements that are of assistance for the work to be rational, economical, and efficient. The didactic unit is a rounded up whole in terms of time and content within which objectives and contents are planned (the size, the depth of the content, its message); approaches in the identification of learning disabilities in the area of organisation of work, fine motor skills, socialisation, and mathematical contents; measures of assistance; monitoring the learner’s progress; evaluation of the measures of assistance.

In the elements of planning the didactic unit from the point of view of learning disabilities the following is determined (summarised from Žakelj & Ivanuš-Grmek, 2010; Ivanuš-Grmek & Javornik Krečič, 2011):

- the psychological aspect (characteristics of the pupils, motivation, etc.);
- general and operational objectives of the didactic unit (the level of urgency of individual objectives and contents from the perspective of assistance to the pupils with learning disabilities; any adaptations of objectives and contents to pupils with learning disabilities);
- contents (size, depth, message, etc.);
- prior knowledge needed for the acquisition of new objectives and contents (degree of urgency of individual objectives and contents from the perspective of assistance to pupils with learning disabilities);
- ways of identifying learning disabilities;
- assistance measures for achieving the objectives while being confronted with any problems (adapted didactic approaches, didactic material, assistance of professional support service at school);

- monitoring the progress of the pupil (diagnostic, formative, summative);
- ways of producing and application of didactic aids/materials (the purpose of didactic aids, who produces the didactic aids/materials; when, why, and for how long the pupil uses the aid, etc.);
- homework (size, purpose, types of homework, homework as means of developing autonomy, creativity, responsibility; homework as means of developing positive attitude toward school, knowledge, school obligations);
- ways of including pupils into cocreating learning and teaching;
- reflection of the teacher and the pupil (questions, any supporting elements for the record).

While planning, the teacher thinks over for which types of difficulties individual measures could be efficient. When it is about pupils with learning disabilities, the teacher must often decide when, for how long and which learning aids the pupils are to use in learning new contents or at verification and assessment of knowledge. E.g.: large grid paper for correct vertical alignment in written summation can be efficient with disabilities related to orientation on the sheet and graphomotor skills, but not if the learner does not understand the procedure of summation. Pocket calculator, for example, can help with solving geometric problems that involve advanced computing problems if the individual poorly masters calculating procedures, but is not efficient in understanding of geometric concepts and relations among them.

While planning for a new didactic unit the teacher thinks carefully over which mathematical concepts or procedures are urgent to be attained by every pupil, which prior knowledge is necessary for the acquisition of new knowledge and how to verify this knowledge; how to identify learning disabilities and to plan assistance measures; how to act if a pupil fails to attain certain contents and objectives. The decision depends on the importance of the contents in further building of knowledge, on its applicability in real life situations, on the type of learning disabilities, particularities of individual learners, etc.

At identification of learning disabilities, teachers pay attention to signs of learning disabilities and to the process of learning that are related to the learning disabilities in mathematics.

When planning, the teacher considers *what measures* can be effective for each type of learning difficulties. When it is about pupils with learning disabilities, the teacher must often decide when, for how long and what teaching aids the pupils should use in learning new contents or in verifying and assessing knowledge. Given the difficulty individuals have with acquiring skills incidentally, it is crucial to provide carefully planned and predictable instruction (Berry & Powell, 2020).

*To cope with learning disabilities strategies of learning and teaching are planned. Strategies are efficient, e.g., where the pupil simultaneously gets insight into correct and incorrect solutions of tasks or is confronted with errors (Siegler, 2002). Siegler (2002) also argues that learning, which provides a parallel insight into correct and wrong problem-solving strategies, into correct and incomplete or wrong conceptions, is more efficient than just explaining the correct approaches to solving or just delivering definitions. A pupil could, e.g., possess a correct strategy for the summation of terms (e.g. reduce the expression with the variables $5a + 3a =$ correctly to $8a$), while the failure to understand the concept of variable would lead him to generalising the application of this strategy also in cases where this approach is not appropriate – he might incorrectly compute that $5a + 4 = 7a$. When the pupil learns and explains incorrect examples, he is directly confronted with irregularities, so it is less likely he would create misconceptions (Siegler, 2002; Ohlsson, 1996). Chi (2000) also emphasises the significance of *reflection*. When the pupil is thinking about strategies and results of solving problems, he is placed into the position to combine new information with prior knowledge and in this way to shape new knowledge. Students will benefit from direct teaching of skills and concepts as well as strategies to encourage active engagement (Berry & Powell, 2020).*

For learning with understanding it is important the teacher assures the right order of learning concepts. Before dealing with new contents he must verify the learners' preknowledge, the conceptual representations that are necessary for understanding new concepts and contents (Žakelj, 2004). Good conceptual understanding of preceding notions that are linked to new notions allow greater probability of internalisation of new information/concepts or contents (Chi, Hutchinson, Robin, 1989). Similarly also Booth Julie L. (2011) states that for pupils with strong conceptual preknowledge about a particular content it is much easier to attain new knowledge, because their prior knowledge makes combining preceding concepts with new notions into a conceptual network possible.

In case of deficits in prior knowledge the teacher plans didactic measures for the elimination of difficulties. Application of didactic aids, different strategies of problem solving, learning investigation skills, interpretation of results (Gobbo & Chi, 1986) allow internalisation of new information/concepts or contents (Chi, Hutchinson, Robin, 1989).

CONCLUSION

Teachers in basic school easily detect pupils with learning disabilities in mathematics, they find out quite soon what a learner is able to do and what not, the detection of deficits is nevertheless mainly random and non-structured. In-depth knowledge of the problem, early detection and appropriate educational and didactic approach create the foundation for planned adjustment of learning and teaching to

the needs of pupils with diverse difficulties in learning mathematics. This is why it is so important the teacher is very well qualified both in her or his professional field as well as in teaching.

In the process of teaching the teacher is successful who offers the pupils overall assistance, which is the most easily achieved by adjusting the learning environment, taking account of the elements of physical, didactic, social, and curricular environment. For the learner the learning environment is the most efficacious in which the teacher provides the learners adequate feedback that assists them in the assessment of their own learning progress; that takes into account the learner's strong areas; eliminates any obstacles for successful teaching, learning, and quality communication in the classroom; clearly defines the expectations and assessment criteria and also provides assistance that allows all learners to learn in the way that suits them the best. A teacher can, however, certainly not carry out all these tasks alone, but only with the support and help of a team of school counselling staff and parents (Kavkler, 2014).

References

- Berry, K. & Powell, S. (2020). *Students with disabilities in mathematics frequently asked questions*. Richmond: Virginia Department of Education.
- Booth, J. L. (2011). Why Can't Students Get the Concept of Math? In M. Mazzocco (ed.): *Perspectives on language and literacy. A Quarterly Publication of The International Dyslexia Association*, 37(2), 31–35. Baltimore: International Dyslexia Association.
- Chi, M. T. H. (2000). Self-explaining expository texts: The dual processes of generating inferences and repairing mental models. In R. Glaser (ed.). *Advances in Instructional Psychology* (161–238). Mahwah, NJ: Lawrence Erlbaum Associates.
- Chi, M. T. H., Hutchinson, J. E. & Robin, A. F. (1989). How inferences about novel domain-related concepts can be constrained by structured knowledge. *Merrill-Palmer Quarterly*, 35, 27–62.
- Gobbo, C. & Chi, M. (1986). How knowledge is structured and used by expert and novice children. *Cognitive Development*, 1, 221–237.
- Ivanuš-Grmek, M. & Javornik Krečič, M. (2011). *Osnove didaktike*. Maribor: Pedagoška fakulteta.
- Johnson, D. & Johnson, R. (1999). Building Community through Cooperative Learning. *Theory into Practice*, 38(2), 67–73.
- Kavkler, M. (2014). Uresničevanje modela odziv na obravnavo za otroke s specifičnimi učnimi težavami. In M. Košak Babuder (ed.): *Otroci in mladostniki s specifičnimi učnimi težavami – podpora pri uresničevanju njihovih potencialov: zbornik prispevkov* (108–110). Ljubljana: Društvo Bravo.

- Peklaj, C. (2001). *Sodelovalno učenje ali Kdaj več glav več ve*. Ljubljana: DZS.
- Ohlsson, S. (1996). Learning from error and the design of task environments. *International Journal of Education Research*, 25(5), 419–448.
- Siegler, R. S. (2002). Microgenetic studies of self-explanations. In N. Granott & J. Parziale (eds.). *Microdevelopment: Transition processes in development and learning* (31–58). New York: Cambridge University Press.
- Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.
- Webb, N. & Palimar, A. (1996). Group processes in the classroom. In D. C. Berliner & B. C. Caffee (eds.): *Handbook of educational psychology* (841–873). New York: Macmillan.
- Žakelj, A. (2004). Process-didactic approach in teaching of mathematics. In I. Prskalo (ed.): *Škola i razvoj = School and development* (267–274). Petrinja: Visoka učiteljska škola. Zagreb: Hrvatski pedagoško-književni zbor.
- Žakelj, A. & Ivanuš Grmek, M. (2010). *Povezanost rezultatov pri nacionalnem preverjanju s socialno-kulturnim okoljem učencev, poukom in domačimi nalogami*. Ljubljana: Zavod RS za šolstvo.
- Žakelj, A. (2012). Odkrivanje in prepoznavanje učnih težav in ukrepi pomoči učencem z učnimi težavami pri matematiki = Detection and identification of learning difficulties as well as the assistance measures for pupils with learning difficulties in mathematics. In S. Kmetič & A. Sambolić Beganović (eds.): *Zbornik prispevkov I. mednarodne konference o učenju in poučevanju matematike – KUPM* (67–78). Ljubljana: Zavod RS za šolstvo.
- Žakelj, A. & Ivanuš-Grmek, M. (2013). Ability grouping and pupils' results on the national assessment of knowledge. *Hrvatski časopis za odgoj i obrazovanje*, 15(2), 439–463.

Амалија Жакелъ

Универзитет на Приморском, Педагошки факултет, Копер, Словенија

Дарјо Фелда

Универзитет на Приморском, Педагошки факултет, Копер, Словенија

Мара Цотич

Универзитет на Приморском, Педагошки факултет, Копер, Словенија

ПОМОЋ УЧЕНИЦИМА СА ПОТЕШКОЋАМА У УЧЕЊУ МАТЕМАТИКЕ

Резиме

У овом чланку ћемо обратити се на то како наставник треба да васпитава и образује ученике који имају различите потешкоће у учењу математике. Акције наставника у планирању и спровођењу процеса учења из перспективе помагања ученицима са потешкоћама у учењу уско су повезане са њиховим погледима и перцепцијама о значају појединачних математичких садржаја као и њиховим перцепцијама наставе, знања, улоге наставника и ученика у настави.

Обликовали смо концептуални дизајн модела заснован на следећим претпоставкама квалитетне наставе за ученике са потешкоћама у учењу: осмишљавање математичког знања из перспективе помагања ученицима са потешкоћама у учењу; настава као узајамна активност ученика и наставника (принцип узајамне одговорности) и принцип учешћа ученика у планирању, спровођењу и вредновању наставе.

Кључне речи: *учење математике, одговорност, активно учење.*