HUMAN, TECHNOLOGIES AND QUALITY OF EDUCATION, 2023
https://doi.org/10.22364/htqe.2023.24

TRANSVERSAL SKILLS IN THE MATHEMATICS EDUCATION CURRICULUM IN PRE-SCHOOL: EXPERIENCE OF LATVIA

Dagnija Vigule[1], Ineta Helmane[1]

[1] University of Latvia, Latvia

ABSTRACT

The acquisition of mathematics begins with the birth of a child within the cultural environment or socio-economic environment of the child. The child learns mathematics by investigating and exploring the environment in which they are located. The article describes and analyses theoretical materials and documents about applying transversal skills for the acquisition of mathematics in the new education curriculum in pre-schools in Latvia. From the school year 2017/2018, new education curriculum is being implemented in Latvia. The research focuses on the analysis of Preschool education curriculum (2019) and Transversal skills in preschool (2019), as well as document "Education for modern literacy: description of the teaching/learning content and approach" (Skola 2030, 2017) giving particular attention to mathematics to be acquired in pre-school. Research questions were chosen in the research aspect of applying the new education curriculum for the acquisition of mathematics in preschool: What transversal skills are included in mathematics education in preschool? What are the essence of transversal skills in preschool education? How are the mathematics learning outcomes in preschool education related to the transversal skills? Main findings reveal the improvement of the learning outcomes by including the transversal skills in the acquisition of mathematics in preschool. Critical thinking and Problem solving as transversal skill dominate in the mathematics education in the preschool curriculum as the learning outcomes. In turn, such transversal skills as Civic participation and Digital literacy are neither included, nor specified in mathematics outcomes.

Keywords: *curriculum, education, mathematics, learning outcomes, pre-school, transversal skills.*

Introduction

The question of priorities in mathematics education has been a topical issue for several decades. Modern mathematics education in preschool is not only content-oriented, but gives equal importance to both the content and the process of mathematics. The child must become a flexible thinker who, with the knowledge of all areas of mathematical content and an understanding of what is being taught, is able to apply mathematical ideas and skills to

everyday life and other activities (National Council of Teacher of Mathematics, 2000). To this end, mathematics learning in preschool involves both content (number and counting, geometry, measurement, data analysis) and process (problem solving, reasoning, communication, connections, and representation) (Bullard, 2017; Robertson, 2017; Cotton, 2019).

The need for changes in Latvian preschool education, including the acquisition of mathematical skills, is also stated in the document "Education for Modern Literacy: a description of the curriculum and approach". Despite the fact that the child is able to solve tasks that require remembering facts and following learned algorithms in familiar situations, difficulties arise in non-standard situations where there is no single learned correct solution to a situation. Children find it difficult to relate theoretical knowledge to real life (Skola 2030, 2017). The education, children receive in preschool, is the foundation for them to benefit from learning opportunities in primary school (Burchinal et al., 2021).

In addition to basic skills such as literacy, numeracy, digital skills and civic participation skills, skills such as creativity, critical thinking, initiative taking and problem solving are becoming increasingly important in today's complex and changing societies (European Commission, 2018). Thus, new Guidelines (2018) were introduced which state that the compulsory curriculum shall be designed with a focus on what is most relevant for the child in learning the content, in order to build literacy (competence) as a complex outcome of the child's learning over a longer period. According to the guidelines, not only knowledge, understanding and basic skills in the subject areas, but also values, virtues and transversal skills (Preschool education guidelines, 2018) constitute the compulsory content of preschool education. By learning social and emotional, executive, mathematical and literacy skills in preschool, children will be better prepared for the higher expectations and requirements, and more formal curriculum in primary school (Burchinal et al., 2022).

Essence of Transversal Skills

Transversal skills are embedded in life activities in the 21st century and have an important place in the knowledge society for lifelong learning (Care & Luo, 2016; Larraz et al., 2017). Transversal skills influence an individual's future competences throughout his life, as well as employment, income, life satisfaction and health (European Commission, 2018).

Transversal skills are essential and transferable across the lifespan and include cognitive and metacognitive skills, as well as they are closely related to subject knowledge and attitudes (Babiloni et al., 2017) and include several important skills that can be acquired, which are necessary for everyone to successfully adapt to change and live a meaningful and productive life (Trzmiel, 2015). Transversal skills comprise skills, values and attitudes that are necessary for learners' holistic development and their ability to adapt to change (Care & Luo, 2016). In preschool, transversal skills include the cognitive, emotional and social aspects of a child's functioning that help them acquire knowledge, understanding and basic skills in areas important to human functioning (Preschool education guidelines, 2018).

Transversal skills are interdisciplinary and go beyond a specific field or curriculum (Flora, 2014). Transversal skills are used in a variety of disciplines, situations and contexts

(Economou, 2016). Transversal skills are crosscutting and transferable across contexts (Sá & Serpa, 2018). Transversal skills are an important component of education at different levels (Larraz et al., 2017) and need to be developed at several stages of education (Gasquet et al., 2017). Transversal skills are the basis of the compulsory content of preschool education and the development of transversal skills is an important goal of preschool education, as they are increasingly needed in a variety of situations, including unfamiliar and complex ones (Preschool education guidelines, 2018).

Methodology

The aim of the study is identify, analyse and assess transversal skills as changes in the mathematics curriculum after the education content reform in the preschool. Therefore, the study used the document analysis, a systematic procedure for reviewing or evaluating documents. Like other analytical methods in qualitative research, the document analysis requires the exploration and interpretation of data in order to clarify meaning, to gain understanding and to develop empirical knowledge (Corbin & Strauss, 2008).

For the purpose of the document analysis, the following criteria were selected: documents for the preschool education stage, including conditions for mathematics learning in preschool, defining the implementation of the preschool pedagogical process in Latvia, defining transversal skills, approved by the Cabinet of Ministers, issued in the period 2013–2023. The analysis of transversal skills in mathematics education in Latvia for preschool includes the analysis of the following documents:

- Preschool education curriculum (Preschool education curriculum / Pirmsskolas izglītības…, 2019);
- The document "Education for modern literacy: description of the teaching/learning content and approach" (School 2030 / Skola 2030, 2017);
- Transversal skills in preschool (Transversal skills in preschool / Caurviju prasmes…, 2019).

The analysis of the documents was based on the following research questions:

- RQ1: What transversal skills are included in mathematics education in preschool?
- RQ2: What are the essence of transversal skills in preschool education?
- RQ3: How are the mathematics learning outcomes in preschool education related to the transversal skills: critical thinking and problem solving, creativity and entrepreneurship, self-directed learning, collaboration, civic participation, digital literacy?

Results

The Preschool Education Curriculum (2019) has been improved to include the transversal skills to be learnt in the preschool and the outcomes that the child has to attain: Critical thinking and problem solving, Creativity and entrepreneurship, Self-directed learning, Cooperation, Civic participation, Digital literacy (Skola 2030, 2017).

Table 1 Transversal skills in mathematics (Preschool education curriculum, 2019)

Transversal skills	1st level			2nd level			3rd level		
	ML	MR	SH	ML	MR	SH	ML	MR	SH
Critical thinking and Problem solving									
Creativity and Entrepreneurship									
Self-directed learning									
Collaboration									
Civic participation									
Digital literacy									

CODE Mathematics Language – ML
Measurements – MR
Shapes – SH

yes partly no

Table 2 Description of civic participation, digital literacy as transversal skills in the preschool curriculum

Transversal skill (Skola 2030, 2017)	**Description of the transversal skill in preschool** (Transversal skills in preschool, 2019)
Civic participation. Conscious action for the society, the environment and people, embracing diversity and influencing community processes.	In preschool, civic participation skills are learned through creating and following group rules, understanding others, empathising and acting in an environmentally friendly way. Children begin to take conscious responsibility and act accordingly. In preschool, children learn to be responsible for themselves, their peers and the environment. In the future, they will form a community where they can feel safe and equal with others and have a say in what happens. They will act appropriately in unacceptable situations.
Digital literacy. Digital literacy helps to use digital technologies effectively, intelligently and responsibly.	In preschool, it is important to learn to distinguish between the virtual and the real world, to understand the role of digital technologies, and to learn to respect the conditions of using digital devices.

The data analysis suggests that the attainment of *Critical thinking and Problem solving* dominate in the preschool curriculum as the learning outcomes are more strongly indicated for the first stage of preschool education in mathematics than for the third stage of preschool mathematics, where the mathematics content dominates in the learning outcomes. In turn, the mathematics outcomes are neither included, nor specified for such transversal skills as *Civic participation* and *Digital literacy* (see Table 1).

Typically, **digital skills** (see Table 2) that could help to use digital technologies effectively, intelligently and responsibly are not taught in preschool mathematics, although digital devices and technologies have become an integral part of modern human learning. However, the preschool curriculum does not provide guidance on how to use these different technologies in a meaningful way to complement teaching and learning in preschool mathematics. Data on preschool children's ability to solve simple, everyday problems, to

use mathematical concepts, to use the language of mathematics in everyday conversations and reasoning skills show that children who use digital devices once a week, as opposed to those who use digital devices every day, show higher achievement in mathematics learning (OECD, 2020). Digital technologies can change how mathematics is taught and learned, as technology can make mathematics meaningful (Papadakis et al., 2021). Different applications encourage preschool children to share their experiences and facilitate the learning of mathematical concepts in geometry, grouping and counting (Magnusson, 2021).

Preschool curricula, regarding the **civic participation** (see Table 2) as a transversal skill for the mathematics literacy, do not envisage outcomes that enable children to understand the interaction between the society, environment and their own personality; nor do they set out to understand the personally meaningful values according to which decisions are made. The inclusion and implementation of civic participation as a transversal skill in mathematics is underestimated; attention should be paid to seeing interconnections in the society, in an environment where community involvement is important. Therefore, in the process of learning the content of mathematics, it is possible to enrich the mathematics content by linking it to things, their interconnectedness, participation and co-responsibility. It is also done by connecting the learning of mathematics content with life situations in which challenges are addressed both from a mathematical point of view and the point of view of a civic participation, e.g. what to do if someone lacks something or has too much of something. Research in mathematics education emphasises that such problems will not be solved with certain specific skills, learned rules that are important in a certain field of activity (Claxton et al., 2016), knowledge that is acquired formally during learning without practical application.

In the preschool curriculum the use of mathematical terms and naming them dominate the results achieved in the acquisition of **cooperation** (see Table 3) as a transversal skill. For instance, *Name the number of objects; Identify the location of an object in space using the concepts of above, below, near, behind, next to; Compare objects using the concepts of more, less, bigger, smaller* (Preschool education curriculum, 2019). However, the cooperative skills component, indicated in the Preschool Programme that the child learns to cope with learning and everyday situations with peers (Skola 2030, 2017), is not addressed in mathematics. Typically, the gradual development of cooperation skills only partially follows a continuum, with a higher number of outcomes being indicated

Table 3 Description of cooperation as transversal skills included in the preschool curriculum

Transversal skill (Skola 2030, 2017)	**Description of the transversal skill in preschool** (Transversal skills in preschool, 2019)
Cooperation. The opportunity to learn from each other in a conscious way, working together to find creative solutions to the needs of the group and individuals, and to gain satisfaction from what has been achieved.	In the early years of preschool, cooperative skills are developed by doing different tasks together with an adult. Over time, the necessary skills in building respectful relationships and using vocabulary develop into a habit. As the child grows up, he/she learns to deal with learning and everyday situations together with peers.

in the second stage of preschool education than in the third stage of preschool education. Outcomes in the two above-mentioned stages may overlap completely, e.g. in the learning of shapes. Outcomes in the second stage are: *Identify the position of an object in space using the concepts above, below, near, behind, next to*, and in the third stage: *Identify the position of objects in space and in the plane using the concepts above, below, near, behind, next to, to the right, to the left* (Preschool education curriculum, 2019).

Thus, in the context of the Preschool curriculum, the acquisition and use of mathematics-related vocabulary is emphasised in the context of cooperation as a transversal skill, which is positive in the context of learning mathematics content. This is because the language of mathematics plays an important role in children's learning of mathematics (Barner et al., 2009; Hornburg et al., 2018; Burchinal et al., 2022). When children understand and practise using mathematical language, they are better equipped to learn mathematics and to engage in conversations where mathematics is discussed (Riccomini et al., 2015; Burchinal et al., 2022). Greater attention should be paid to ensuring that children use the vocabulary they learn in their communication with adults and peers. When playing with peers, talking with an adult, children hypothesise, ask questions, and formulate answers. Often the answers to questions from both peers and adults may be contradictory; they may differ from the child's experience, but this is what gives the child a new understanding of what is going on. It is this experience that allows the child not only to construct, but also to expand and restructure his or her knowledge (Copple & Brendekamp, 2009; Kostelnik et al., 2014).

The following **self-directed learning** (see Table 4) skills as a transversal skill are identified in preschool: to plan own actions, to monitor own actions, to recognise, to name and monitor own emotions, to reflect on own growth, direct own growth (Transversal skills in preschool, 2019). Self-directed learning also involves asking questions rooted in the child's interests and expressions of curiosity. Self-directed learning allows children to explore, create, adapt, modify and play with ideas, as children are the determinants of the learning process. They begin to gain greater self-determination and freedom over their learning (Stone, 2016; Alwadaeen & Piller, 2022). The mathematics learning outcomes included the following self-directed learning skills:

- planning, where the child learns to predict the outcome of a situation, learns to be aware of the purpose of his/her actions, and plans one or more actions to achieve his/her intentions (Transversal skills in preschool, 2019). For example, *Fetches, takes away, puts objects according to a certain shape; Handles objects, places them in a certain place, e.g. a leaf on a table, a trolley under a shelf; Independently chooses a feature to group objects by* (Preschool education curriculum, 2019).
- implementing and monitoring his/her actions when the child perseveres to achieve the desired outcome; independently tries to overcome difficulties, looks for new solutions, changes the plan and adapts to the situation; asks others for help when necessary (Transversal skills in preschool, 2019). For example, *Works practically with the counting material, exploring number composition; Chooses an appropriate number (1–5) to represent the number of objects* (Preschool education curriculum, 2019).

Table 4 Description of self-directed learning as transversal skills included in the preschool curriculum

Transversal skill (Skola 2030, 2017)	**Description of the transversal skill in preschool** (Transversal skills in preschool, 2019)
Self-directed learning. Conscious judgement, reflection on one's own learning activities and the ability to guide one's own learning in any life situation, context.	Self-directed learning in preschool is promoted by developing the ability to be aware of and manage one's emotions, thoughts and behaviour, by learning to set goals, to plan how to achieve them and implement the plan, evaluating the process and the results in order to achieve growth.

Table 5 Description of creativity and entrepreneurship as transversal skills in the preschool curriculum

Transversal skill (Skola 2030, 2017)	**Description of the transversal skill in preschool** (Transversal skills in preschool, 2019)
Creativity and entrepreneurship. Creativity is the process of generating new ideas that are useful to a person or a group of people. Entrepreneurship allows putting these ideas into practice, achieving one's own and societal goals.	In preschool, a child is ready to learn something new, to create ideas and to implement them. Playing and experimenting with familiar activities and objects, the child creates different combinations of things never experienced before, strengthens the desire to learn new knowledge and skills, and develops the habit of showing initiative and complete the started activities.

However, the mathematics outcomes are not specified for self-directed learning as a transversal skill such as: reflecting on own growth, guiding own growth. In mathematics, it is not expected that the child reflects on his/her own growth, guides his/her own growth by evaluating the process and outcome of his/her work according to criteria given by the teacher or set by the child, by being aware of his/her achievements and difficulties, and by taking action to improve his/her performance.

As **creativity** (see Table 5) is the process of generating new ideas, which are useful to a person or a group of people (Skola 2030, 2017), the mathematics outcomes indicate that the outcome for the child is to see and respect diversity. There should be a particular focus on reducing stereotypes, e.g, *Conditionally and creatively makes arrangements, including rhythmic rows, of objects and geometric shapes that differ by one characteristic*; *Invents and arranges their own arrangements, including rhythmic rows* (Preschool education curriculum, 2019). During the third stage of preschool education, in Learning shapes, special attention is paid to innovation: *Through hands- on activities the child is able to divide a shape into parts, obtaining new shapes, e.g. from a quadrilateral two triangles are obtained*; *Experiments with shapes, e.g. by combining them, creates another shape and relates it to a familiar object* (Preschool education curriculum, 2019). No similar simpler activities are intended in the earlier stages of education.

Despite the fact that the regulatory documents defining the preschool process emphasise that **entrepreneurial skills** (see Table 5) enable students to put these ideas into practice, achieving their own and society's goals (Skola 2030, 2017), the mathematics outcomes of the preschool programme do not include entrepreneurial skills as a transversal skill. This could be because entrepreneurship is a different and relatively new skill in the field

of education (Deveci, 2018). Entrepreneurship should be learned through practical application rather than theoretically (Sijde et al., 2008). Learning entrepreneurial skills such as planning, organising, academic risk-taking, communication, and teamwork are important for everyone to be successful and productive in their professional lives (Harari, 2018).

The analysis of the data showed that the Mathematics learning domain is most closely related to **critical thinking** and **problem solving** as transversal skills (see Table 6), as the nature of these skills corresponds to the process of learning mathematics, including the components and activities that are important in learning mathematics.

This is in line with the trend in mathematics education for several decades where the development of thinking skills, including critical thinking, has been given special attention in mathematics education (Jacobs et al., 2007; Sfard & Kieran, 2001). Critical thinking is the art of analysing and evaluating thinking with a view to improving it (Paul & Elder, 2008), as well as an important skill in problem solving, discovery and research (Thompson, 2011). Critical thinking is essential for life in the information age (Connor-Greene & Greene, 2002), a prerequisite for education (Sezer, 2008). Problem solving as a transversal skill, on the other hand, is consistent with the four stages of the problem-solving process in mathematics formulated by Pólya: understanding the problem, developing a plan, implementing the plan and reviewing the work (Pólya, 1945). Problem solving skills include the ability to mathematically interpret a real situation, choose a solution strategy, develop the solution process, change the strategy if necessary, and reflect on one's work and results (Samo et al., 2017).

The curriculum, describing the learning area of mathematics, gives references to the outcomes of critical thinking and problem solving skills (see Table 7). For example, *The child solves a problem in a mathematical way; The child begins to learn to verify a statement – makes an assumption; The child can process and analyse data about objects, situations, events, processes mathematically to make informed decisions* (Preschool education curriculum, 2019). The analysis of the mathematics learning outcomes for all three preschool stages revealed that they mainly focused on mathematics content and the development of critical thinking. For example, *During hands-on activities, the child investigates, selects, finds, distinguishes, sorts, groups, compares, counts objects, explores, describes geometric shapes and figures* (Preschool education curriculum, 2019).

Table 6 Critical thinking and problem solving as transversal skills in the preschool curriculum

Transversal skill (Skola 2030, 2017)	**Description of the transversal skill in preschool** (Transversal skills in preschool, 2019)
Critical thinking and problem solving. Targeted analysis of information and situations, evaluation, finding and implementing solutions.	In preschool, these skills are acquired by observing, studying natural objects and phenomena, identifying and naming different relationships, understanding the sequence of actions, causes and consequences, evaluating the reliability of what is seen and heard, as well as solving everyday problem situations.

Table 7 Critical thinking and problem solving as transversal skills (Skola 2030, 2017)

Critical thinking as a transversal skills	Problem solving as a transversal skill
Analyse: investigate and observe details, compare, contrast, look for and see relationships in objects and processes	• Define a problem or opportunity: recognise and explain own and others' needs and problems, learn to formulate a preferred solution to a specific need or problem
Synthesise: connect, combine, transform, represent simple information experienced, heard, seen in play activities	• Evaluate and choose a solution: evaluate their own solutions and those proposed by others, choose which to implement, learn to justify their choices
Evaluate: assess and compare information obtained in different ways according to certain criteria and attributes	• Plan and implement a solution: use trial and error method or purposeful planning to solve a problem, if unsuccessful seek other solutions
Conclude: see and explain simple relationships, cause and effect, make generalisations based on previous experience and known information	• Check and evaluate the solution: evaluate whether and how the problem was solved, learn to formulate what is harder or easier to do

The curriculum describes the goal of mathematics learning or literacy at the end of preschool education and outlines the big ideas. The text contains references to problem-solving skills, for example, *The child solves a problem in a mathematics-specific way, The child begins to learn how to verify a statement – makes an assumption conjecture, the child understands by doing that data about objects, situations, events, processes can be processed and analysed mathematically to make informed decisions* (Preschool education curriculum, 2019). However, in the outcomes for the child only indirectly and only at the third stage of preschool education there are indications of problem-solving skills, e.g. *The child makes an assumption about the number in pictures and in sets of objects and checks, explains, verifies his/her assumption by counting* (Preschool education curriculum, 2019).

When a child engages in activities where mathematical content is revealed, he/she receives support from an adult for thinking, analysis, and reasoning. This means that the child does not receive answers, one correct solution from the teacher, but obtains them by trying, making mistakes, cooperating, discussing, exchanging opinions, predicting, and concluding. A good problem situation encourages the child to analyse, synthesise, evaluate the information, events, ideas, and does not always have one definite solution. The child's own judgements, conclusions help to make new mental connections and generate new ideas. The child's wrong answers, misjudgements should be heard, they can be indirectly guided by engaging the child in a discussion, challenging him/her to look at an event, an idea, information in a different way. In this way, even children's mistakes and misjudgements can be used to plan future learning activities.

Without solving daily and teacher-modelled problem-solving situations that are purposefully developed and only engaging in formal activities, it is impossible to develop the skills of problem-solving, reasoning, searching, seeing patterns, and communicating about what has been learned. The child should develop the impression from pre-school

age that mathematics is more than specific skills and that its content is more than counting, measuring, recognising shapes and figures. The preschool teacher should not be engaged in a retelling of mathematical facts, but should think how to organise the learning experience in a purposeful way so that the child sees the meaning of what is being learnt, helping the child to relate informal knowledge, which is learnt in playing, in everyday life, to formal knowledge. Without developing a strong understanding of mathematics in the early years, children too often believe that mathematics is a guessing game and a system of rules without a foundation (Munn, 2006). Mathematics is not about finding the right answer, but the skill of being able to draw conclusions, analyse, compare and apply personal life experiences.

This is also what the new preschool curriculum, which "reflects the expected outcomes for the child at each stage of preschool education in a sequential manner" (Preschool education curriculum, 2019, 5), requires of preschool teachers. The child gets the first conscious learning experience in preschool, which becomes the foundation for all future learning experiences. In the preschool curriculum, unlike the 2012 curriculum (Preschool education curriculum, 2012), the learning of mathematics in preschool focuses on the achievement of specific outcomes in a meaningful learning process. The emphasis is on actively involving the child in a variety of activities and providing effective feedback that focuses on the child's learning rather than praise or blame. The curriculum specifies how the learning process should be organised and managed so that learning is meaningful and the child is an active participant in the learning process, so that the child develops understanding rather than rote learning.

Conclusions

- The new mathematics curriculum incorporates the planning of the mathematics teaching/learning content and the learning outcomes. The innovation in the new mathematics curriculum is defining the transversal skills. Transversal skills include the cognitive, emotional and social aspects of a child's actions that help them acquire knowledge, understanding and basic skills in areas important for human functioning. However, mathematics content is characterised by its dominance over the mathematical process and transversal skills, their acquisition in preschool.
- Critical thinking and Problem solving as transversal skills are dominant in the preschool curriculum in the field of mathematics education. Typically, the mathematics learning outcomes focus more on critical thinking and less on problem solving.
- Civic participation and Digital literacy as transversal skills are not included in the preschool curriculum in the field of mathematics education. While it would be desirable to include both civic participation and digital literacy in learning the mathematics content, thus linking the mathematics learning outcomes to real-life situations in which a variety of practical tasks are tackled from both a mathematics perspective and from a civic participation and digital literacy perspective.

- Learning outcomes of transversal skills are transferable across contexts and specific transversal skills. One specific learning outcome can be included under different transversal skills, for instance, Critical thinking and Problem solving and Creativity and Entrepreneurship include similar learning outcomes. However, the purpose of the activity, the outcome it aims to achieve for the child determines the belonging to a particular transversal skill.

REFERENCES

Alwadaeen, N. B., & Piller, B. (2022). Enhancing Self-directed Learning Readiness at Elementary Level, a Study from American Schools. *Journal of Curriculum and Teaching, 11*(4), 24–38. https://doi.org/10.5430/jct.v11n4p24

Babiloni, E., Guijarro, E., Canós-Darós, L., & Santandreu-Mascarell, C. (2017). *Transversal Competences Acquisition by Assigning Collaborative Work Group Roles. Entrepreneurship and University: How to Create Entrepreneurs from University Institutions* (pp. 179–196). Springer. https://doi.org/10.1007/978-3-319-47949-1_12

Bullard, J. (2017). *Creating Environments for Learning: Birth to Age Eight* (3rd ed.). Pearson Education.

Burchinal, M., Krowka, S., Newman-Gonchar, R., Jayanthi, M., Gersten, R., Wavell, S., Lyskawa, J., Haymond, K., Bierman, K., Gonzalez, J. E., McClelland, M. M., Nelson, K., Pentimonti, J., Purpura, D. J., Sachs, J., Sarama, J., Schlesinger-Devlin, E., Washington, J., & Rosen, E. (2022). *Preparing Young Children for School (WWC 2022009).* Washington, DC: National Center for Education Evaluation and Regional Assistance (NCEE), Institute of Education Sciences, U.S. Department of Education. https://files.eric.ed.gov/fulltext/ED621926.pdf

Barner, D., Chow, K., & Yang, S.-J. (2009). Finding one's meaning: A test of the relation between quantifiers and integers in language development. *Cognitive Psychology*, *58*(2), 195–219. https://doi.org/110.1016/j.cogpsych.2008.07.001

Caurviju prasmes pirmsskolā [Transversal skills in preschool]. (2019). https://mape.skola2030.lv/resources/357 (in Latvian)

Cotton, T. (2019). *How to Develop Confident Mathematicians in the Early Years*. Routledge. https://doi.org/10.4324/9781315211398

Care, E., & Luo, R. (2016). *Assessment of Transversal Competencies: Policy and Practice in the* Asia Pacific Region. The United Nations Educational, Scientific and Cultural Organization. https://neqmap.bangkok.unesco.org/wp-content/uploads/2019/09/246590eng.pdf

Claxton, G., Costa, A., & Kallick, B. (2016). Hard thinking about soft skills. *Educational Leadership, 73*, 60–64.

Corbin, J. & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Sage. https://doi.org/10.1177/1094428108324514

Connor-Greene, P. A., & Greene, D. J. (2002). Science or snake oil? Teaching critical evaluation of "research" reports on the internet. *Computers in Teaching*, *29*(4), 321–324. https://doi.org/10.1207/S15328023TOP2904_14

Copple, C., & Bredekamp, S. (2009). *Developmentally appropriate practice in early childhood programs serving children from birth through age 8* (*3rd ed.).* National Association for the Education of Young Children.

Deveci, İ. (2018). Science-based entrepreneurship scale for middle school students: a validity and reliability study. *Journal of Multidisciplinary Studies in Education*, *2*(1), 1–15.

Economou, A. (2016). Research Report on Transversal Skills Frameworks. Cyprus Pedagogical Institute, Ministry of Education and Culture.

European Commission. (2018). Proposal for a Council Recommendation on Key Competences for Life Long Learning. https://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:52018SC0014&from=EN

Flora, N. (2014). Contribution to Gender Studies for Competences Achievement Stipulated by National Qualifications. *Journal of Research in Gender Studies*, *4*(2), 741–750. https://www.ceeol.com/search/article-detail?id = 2974

Gasquet P. G., Verdecho M. J., Rodriguez R. J., & Saiz J.J. (2017). Formative Assessment Framework Proposal for Transversal Competencies: Application to Analysis and Problem Solving Competence. *Journal of Industrial Engineering and Management JIEM*, *11*(2), 334–340. https://doi.org/10.3926/jiem.2504

Harari, Y. N. (2018). *21 Lessons for the 21st Century*. Random House.

Hornburg, C. B., Schmitt, S. A., & Purpura, D. J. (2018). Relations between preschoolers' mathematical language understanding and specific numeracy skills. *Journal of Experimental Child Psychology*, *176,* 84–100. https://psycnet.apa.org/doi/10.1016/j.jecp.2018.07.005

Jacobs, V. R., Franke, M. L., Carpenter, T. P., Levi, L., & Battey, D. (2007). Professional development focused on children's algebraic reasoning in elementary schools. *Journal for Research in Mathematics Education, 38*(3), 258–288. https://doi.org/10.2307/30034868

Kostelnik, M.J., Rupiper, M.L., Soderman, A.K., & Whiren, A.P. (2014). *Developmentally Appropriate Curriculum in Action.* Pearson.

Larraz, N., Vázquez, S., & Liesa, M. (2017). Transversal skills development through cooperative learning. Training teachers for the future. *On the Horizon*, *25*(2), 85–95. https://doi.org/10.1108/OTH-02-2016-0004

Magnusson, L. O. (2021) "Look, my name! I can write"– Literacy events and digital technology in the preschool atelier. *Journal of Early Childhood Literacy.* https://doi.org/10.1177/14687984211058943

Munn, P. (2006). Mathematics in early childhood – the early years math curriculum in the UK and children's numerical development. *International Journal of Early Childhood*, *38*(1), 99–111. https://doi.org/10.1007/BF03165980

National Council of Teachers of Mathematics. Principles and Standards for School Mathematics (2000). Reston, NCTM.

Noteikumi par valsts pirmsskolas izglītības vadlīnijām [Rules on national pre-primary education guidelines]. (2012). https://likumi.lv/ta/id/250854 (in Latvian)

Noteikumi par valsts pirmsskolas izglītības vadlīnijām un pirmsskolas izglītības programmu paraugiem [Regulations Regarding Guidelines for State Pre-School Education and Samples of Pre-School Education Programmes]. (2018). https://likumi.lv/ta/id/303371/redakcijas-datums/2019/09/01 (in Latvian)

OECD (2020). *Early Learning and Child Well-being: A Study of Five-year-olds in England, Estonia and the United States*. OECD Publishing. https://doi.org/10.1787/3990407f-en

Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2021). Teaching mathematics with mobile devices and the Realistic Mathematical Education (RME) approach in kindergarten. *Advances in Mobile Learning Educational Research*, *1*(1), 5–18. https://doi.org/10.25082/AMLER.2021.01.002

Paul, R., & Elder, L. (2008). Critical thinking: the nuts and bolts of education. *Optometric Education*, *33(3),* 88–91. https://journal.opted.org/files/Volume_33_Number_3_Summer_2008.pdf

Pirmsskolas mācību programma [Preschool Education Curriculum]. (2019). https://mape.skola2030.lv/resorces/10 (in Latvian)

Pólya, G. (1945). *How to Solve It*. Princeton University: Princeton

Riccomini, P. J., Smith, G. W., Hughes, E. M., & Fries, K. M. (2015). The language of mathematics: The importance of teaching and learning mathematical vocabulary. *Reading & Writing Quarterly: Overcoming Learning Difficulties*, *31*(3), 235–252. https://doi.org/10.1080/10573569.2015.1030995

Robertson, J. (2017). *Messy maths: A playful, outdoor approach for early years*. Independent Thinking Press.

Sá, M. J., & Serpa, S. (2018). Transversal Competences: Their Importance and Learning Processes by Higher Education Students. *Education Sciences*, *8*(3). https://doi.org/10.3390/educsci8030126

Samo, D.D., Darhim, D., & Kartasasmita, B. (2017). Culture-Based Contextual Learning to Increase Problem-Solving Ability of First Year University Student. *Journal on Mathematics Education*, *9*(1), 81–94. https://doi.org/10.22342/jme.9.1.4125.81-94

Sezer. R. (2008). Integration of critical thinking skills into elementary school teacher education courses in mathematics. *Education*, *128*(3), 349–362.

Sfard, A., & Kieran, C. (2001). Cognition as communication: Rethinking learning-by-talking through multi-faceted analysis of students' mathematical interactions. *Mind, Culture and Activity, 8*(1), 42–76. https://doi.org/10.1207/S15327884MCA0801_04

Sijde, V. D. P., Ridder, A., Blaauw, G., & Diensberg, C. (Eds.). (2008).*Teaching entrepreneurship: cases for education and training*. Springer. https://doi.org/10.1007/978-3-7908-2038-6

Skola 2030. Izglītība mūsdienīgai lietpratībai: mācību satura un pieejas apraksts [School 2030. Education for modern literacy: description of the teaching/learning content and approach]. (2017). VISC. https://skola2030.lv/admin/filemanager/files/2/prezentacija_izgl_musdienigai.pdf (in Latvian)

Stone, B. (2016). Playing around in Science: How Self-Directed Inquiry Benefits the Whole Child. *International Journal of the Whole Child*, *1*(1), 1–10. https://libjournals.mtsu.edu/index.php/ijwc/issue/view/64

Thompson, C. (2011). Critical Thinking across the Curriculum: Process over Output. *International Journal of Humanities and Social Science, 1*(9), 1–7.

Trzmiel, B. (2015). *Transversal Skills in TVET: Policy Implications*. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000234738

About Authors

Dagnija Vigule – Assistant Professor of Education at the University of Latvia, Faculty of Education, Psychology and Art with focus on Mathematics and Technology education in preschool. The author of several scientific publications on preschool educational content, mathematics, technology and visual art teaching/learning.

Ineta Helmane – Associate Professor of Education at the University of Latvia, Faculty of Education, Psychology and Art with focus on Mathematics education in preschool and primary school. She is a Head of Preschool Education and Primary School Education Department at Faculty of Education, Psychology and Arts in University of Latvia. The author of several scientific publications on educational content, mathematics teaching/learning, integrated education, interdisciplinary approach in education, teacher's professional competence, etc. Dr. Helmane is the author of textbooks, interactive materials and teaching tools for mathematics education in preschool and primary school.