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Mind Maps and Convergent Thinking of Second-Grade Students – Reports from a Pilot Study

Abstract

The article discusses the use of mind maps as a tool supporting the development of convergent thinking in second-grade primary school students. The theoretical foundations of mind maps according to Tony Buzan and the results of research confirming the effectiveness of this note-taking technique are presented. Issues related to convergent thinking in the view of J.P. Guilford are also described. The effectiveness of mind maps was tested using a quasi-experiment. The study was a pilot study aimed at validating the test – a research tool. The constructed test of the level of convergent thinking took into account the indicators given by J.P. Guilford: class production, systems production, transformation production and implication production. The results showed that at the initial stage, the levels in both the experimental and control groups were low in most of the students. After a series of classes on the implementation of mind maps in the experimental group, the number of students with a medium and high level of convergent thinking increased. There were also positive developments in the production of semantic implications. These changes, although partially statistically significant, indicate the potential of this method in developing convergent thinking in students. Therefore, it is worth implementing mind maps in early school education and expanding research in this area.

Keywords: mind maps, convergent thinking, students, early school education.

Introduction

The ability to learn as a key competence should be developed in contemporary students starting from early school education. To do this, students need to learn strategies for remembering information and consolidating it.

> As children grow up, they become more and more proficient in using various strategies that help them at every stage of memorization – coding, storing and recalling information (Schaffer, 2006, p. 277).[1]

Notes created by students are important in the learning process. In Polish schools, linear notes dominate, which make it difficult to add information and are not very attractive, especially for younger students. It is also worth adding that each student has their own individual learning style and therefore, after learning how to remember and create notes, they have the opportunity to choose solutions that are effective for them.

One of the ways of taking notes is mind maps, the originator of which was Tony Buzan. When creating mind maps, students use lines, colors, symbols, images, keywords, etc. The radial arrangement of mind maps resembles structures in the brain – the formation of new connections between neurons. Thus, mind maps help to integrate and visualize the concepts you have learned. This is crucial because, as Anna Jurczak notes,

> comparing a child's brain to a cabinet with many drawers, it can be said that each of them contains a part of the knowledge possessed by them, but the ability to combine it is negligible, because each drawer has a space that it does not share with another (Jurczak, 2016, p. 41).

It should also be noted that mind mapping is attractive to students, including younger ones. They can use colorful images, symbols, made as best they can. Moreover, the visuals are not limited by nationality or language and are the best tool for younger students to discover new things and learn. Depiction through images is one of the most primal human qualities, and the ability to draw in young children is better than the ability to write. Elżbieta Płóciennik emphasizes,

> images are an important element of human cognition, experience, they help to create a representation of the world, because they are a carrier of various content (data on the characteristics of physical objects and people, on relations between objects, relations and interactions between people, and events related to objects and social) (Płóciennik, 2011, p. 176–177).

Therefore, it is worth implementing mind maps in grades 1–3 as a method of creating notes, because their creator emphasized a number of advantages, m.in. help in understanding and remembering information, organizing thoughts into a clear, hierarchical structure, saving time and making the most of it (see Buzan, Buzan, 2002; Buzan, 2003). Students should learn a new way of taking notes and choose the right one that will help them in the learning process.

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[1] All translations into English of the original texts are the author's own translations.

Tony Buzan's Mind Maps

Mindmapping has been known since the 60s/70s of the twentieth century, and its assumptions were developed by Tony Buzan. According to T. Buzan and B. Buzan, mind maps

> are an expression of multidirectional thinking, and therefore a natural function of our mind. It is also a wonderful graphic technique that unleashes the potential of the intellect. Maps can be successfully used in all areas of life where the speed of learning and clarity of thinking improve the results achieved (Buzan, Buzan, 2002, p. 57).

In mind map definitions, attention is focused on the structure and effects of using this technique. For example, the Oxford Dictionary states that it is an information diagram presenting correlated ideas organized around a central idea (Oxford Dictionary), and according to Brinkmann, mind mapping is a powerful technique that allows thoughts to be expressed in the mind and reveals the brain's potential (Brinkmann, 2003).

A mind map has a radial structure that can resemble a tree. In the center is the main theme, from which interconnected branches of different thicknesses diverge to indicate connections. According to Buzan, this structure makes it easier to detect connections between different branches and create new associations to fill any empty spaces, thus encouraging us to keep thinking creatively (Buzan, 2019). For comparison, notes popular in schools are linear, students write down information line by line, use one color of pen (black or blue), sometimes they only underline certain issues, mainly the topic of the lesson, with a different color. This way of writing does not allow you to supplement the note with new information, let alone associations or drawings.

In order to prepare a mind map, you should have a blank sheet of paper (without lines), preferably A4, colored pens, and remember to go from the general information to the detail. When creating, it is worth taking into account the principles formulated by the creator of mind maps:

— the sheet is placed horizontally;
— in the middle of the page is a drawing that summarizes the main topic;
— the central branches that depart from this figure represent the main subtopics;
— from them depart interconnected lines that concern details;
— there are keywords or drawings on the branches;
— each added keyword or and-key creates new possibilities for connections, which in turn evoke further associations (Buzan, Buzan, 2002; Buzan, 2003).

Mind maps allow students to analyze the discussed issue or the text they read from the textbook by creating branches, thus developing the ability to categorize and hierarchize. What's more, this way of taking notes allows you to

present dependencies and connections between individual issues. According to Agnieszka Kaczor, such a statement

> is not only a reflection of the student's knowledge, but more importantly, it is empirical evidence of the commitment he or she showed while working on the topic (Kaczor, 2020, p. 79).

Therefore, thanks to a mind map, the student not only reproduces the content, but also processes it, analyzes and organizes it. In addition, mind maps have numerous advantages indicated by their creator and it is also worth mentioning the time saving (writing down important words, repeating important things instead of reading several pages of notes).

Mind maps can be used to achieve various educational goals. The results of the study confirm the effectiveness and efficiency of the mind mapping technique in teaching and teaching a variety of subjects, e.g. mathematics (Brinkmann, 2003), economics (Budd, 2004), foreign languages (Haiyao et al., 2025). In the context of language learning, a systematic review of research from recent years indicates that mind maps are an effective tool in learning vocabulary or grammar.

In addition, numerous foreign studies confirm the effectiveness of mind maps in the following areas:

— improving learning performance and understanding of the material;
— problem-solving and critical thinking;
— increasing student motivation and engagement.

Mind maps help you organize and understand complex information. Research indicates that mind maps support the development of critical thinking and improve student performance (Rezapour-Nasrabad, 2019; Keter et al., 2021; Naibaho, 2022). What's more, Buran and Filyukov (2015) found that this note-taking technique supports students in solving problems and coming up with creative ideas. It is also worth noting the effectiveness of mind maps in terms of motivation to learn. Mind maps are seen as a tool to engage and stimulate students to actively process information (Sabarun et al., 2021; Zheng et al., 2020).

The examples of research results cited indicate the usefulness of mind maps in the learning process of students at different stages of education.

Convergent thinking

In the learning process, researchers point to the essence of two types of thinking – convergent and divergent. In the context of the topic of this article, it is necessary to present assumptions concerning the first of the above-mentioned types of thinking. According to J.P. According to Guilford,

> convergent production belongs to the field of logical education, or at least to the field of the ability to draw conclusions. It is this, not divergent generation, that prevails when the input of information is sufficient to establish a unique response (Guilford, 1978, p. 335–336).

It is most often used in situations familiar to the individual, it does not require the use of new thinking patterns. At the stage of early school education, it may be a task consisting in indicating the appropriate caption to animal drawings, indicating the next number in a given sequence. As Maria Ledzińska and Ewa Czerniawska emphasize,

> it consists in the fact that a person uses narrowing down the possibilities of choice (thoughts) in order to arrive at one optimal solution (Ledzińska, Czerniawska, 2011, p. 55).

Important in convergent manufacturing are the ways in which the mind organizes and classifies information during the problem-solving process. The following are listed in the literature on the subject:

— individuals refer to the ability to perceive individuals in the area of content,
— classes refer to the ability to organize individuals into meaningful groups and sort individuals into appropriate groups,
— relationships refer to the ability to sense relationships between pairs of individuals,
— systems consist of relationships between more than two entities,
— transformations are the ability to understand changes in information,
— implications relate to expectation (Barlow, 2000).

The division proposed by Guilford (1978) with respect to the convergent production of units, classes, relations, transformations and systems should be presented.

— Converging unit generation
  – semantic units.
— Converging Class Generation
  – figural classes,
  – semantic classes.
— Converging relationship generation
  – symbolic relations,
  – semantic relations.
— Converging system manufacturing
  – symbolic systems,
  – semantic systems.
— Converging transformation generation
  – figural transformations,
  – symbolic transformations,
  – semantic transformations

— Converging Implication Manufacturing
  – symbolic implications,
  – semantic implications.

Convergent thinking is crucial in situations that require finding a single, optimal answer and is developed through logical and analytical exercises. Convergent thinking develops mainly in the stage of concrete operations, according to Piaget's classification of cognitive development, and is fully developed in the stage of formal operations. Well, in the period of 7–11 years (the stage of concrete operations), "the child develops the ability to use logical thinking to solve specific problems that arise at a given moment" (Wadswoth, 1998, p. 39). Students most often practice convergent thinking when solving tests or mathematical tasks. For example, the students' task is to count objects after adding two sets or match the names of professions to attributes. As Ewa Filipiak points out, "the abilities assessed by the subtests of convergent production are related to the development of school skills: literacy, arithmetic skills" (Filipiak, 2015, p. 165). However, it should be emphasized that for the full development of students, it is important to develop divergent thinking in parallel, which will allow them to better cope with the challenges of the modern world and develop creativity.

Research methodology

The conceptualization of the key concepts of the thematic area is based on the scientific theory discussed in the publications of T. Buzan and J.P. Guilford.

The cognitive goal of the research is to gain knowledge about the importance of using mind maps for the development of convergent thinking in second-grade students.

The following research problems were formulated:

— exploratory and diagnostic: What is the effectiveness of using mind maps in developing convergent thinking in second-graders, taking into account the level of convergent thinking in the control and experimental groups?
— Verification:
  – Does the creation of mind maps by second-grade students affect the convergent production of classes?
  – Does the creation of mind maps by second-grade students affect the convergent production of systems?
  – Does the creation of mind maps by second-grade students affect the convergent production of transformations?
  – Does mind mapping by second-grade students affect the convergent production of implications?

The designed research is a pilot study and is an introduction to longitudinal research, the subject of which will be the effectiveness of the use of mind maps in the development of convergent and divergent thinking in the second and third grades of primary school. The pilot was used to validate the research tool. The author constructed a test to learn the level of convergent thinking on the basis of J.P. Guilford's proposed tasks.

The research method was adopted in the designed research – a quasi-pedagogical experiment. The selection of the research group was deliberate, because in order to carry out the research in the primary school, two second grades were indicated. Thus, as stated by John W. Creswell (2013), the randomization requirement is necessary, and failure to meet it makes the experimental model (not meeting the definition requirements) a quasi-experimental model.

The control group was made up of second-grade students who do not know the mind map and only create linear notes. The group consisted of 11 people. The experimental group (16 people) are second-grade students who were familiarized with the principles of mind mapping and applied them in the winter semester of the 2024/2025 school year. The author conducted ten lessons in the field of mind maps by T. Buzan with students of the experimental group. In addition, students created maps with the teacher on the discussed issue (they had previously been given to the teacher by the author of the research) and independently during lessons. The participants of both groups were of the same age and were students of the same primary school. The designed research was carried out at several stages, which are presented in Table 1.

Table 1
Stages of the research

	Pretest	**Mind Mapping Classes by T. Buzan**	**Posttest**
Experimental group	X	X	X
Control group	X		X

Source: Author's research.

Research tools – the convergent thinking level test included 9 tasks that corresponded to individual indicators and related to issues known to children. The indicators were selected on the basis of Guilford's classification. During the selection, information about the ineffectiveness of some tests was taken into account, which, showing secondary loads, is not an unambiguous measure. Therefore, the test included tasks related to:

— convergent class manufacturing
  – semantic classes – word grouping test. The task was to classify 12 commonly used words into a certain number of classes.

— Converging system manufacturing
  – symbolic systems – word changes test. The task was to indicate the order of the given words in order to move from the word coffee to the word basket, changing only one letter.
  – semantic systems
    a) picture arrangement test. The task was to indicate the correct order of the drawings – the correct crossing of the street.
    b) sentence order test adapted from Adkins and Lyerly. The task is to put the three sentences in the right order. Each corresponds to an episode in a certain series of events.
    c) Word Matrices test. The task is to complete the table (3 rows and 3 columns) with the given words, in such a way that they share a common feature, e.g. vehicles.
— Converging transformation generation
  – symbolic transformations – a test of camouflaged words. In the sentences, it was necessary to find and underline hidden names appearing in the food pyramid.
— Converging Implication Manufacturing
  – symbolic implications
    a) Form reasoning test. Given simple equations – a given figure is implied by a combination of two others. The task is to indicate the correct result.
    b) sign changes test. The task was to solve a simple mathematical operation according to the given instruction – to replace one character of the operation with another sign.
  – semantic implications – a test of sequential associations. The task was to arrange the words in such a way that there would be a natural connection between the first and the second, the second and the third, and so on – grain, grain, flour, bread.

The collected data were subjected to statistical analysis in SPSS Statistics 28.0. Pearson's chi-square analysis was used to examine intragroup and intergroup differences in the level of convergence thinking converted into norms. The descriptive statistics and statistics of the Shapiro–Wolf test of the study variables in the experimental and control groups and in two measures: pretest and posttes were evaluated. The values of skewness in the range from −2.51 to +3.32, and kurtoses in the range from −2.04 to +11.00 showed that the assumption of normality of the data distribution was not met. These findings confirmed the relevant statistics of the Shapiro–Wolf test for most variables. On this basis, the analyses were carried out using the nonparametric Wilcoxon rank test for two dependent samples and *the* Mann-Whitney U test for two independent samples. The significance of the results was assumed at the level of $\alpha = 0.05$.

Mind Maps and Convergent Thinking of Grade 2 Students – Results of a Pilot Study

On the basis of the data collected, it should be concluded that Both groups started with the same low level of convergent thinking. After applying mind maps, at the trend level, the results in the experimental group moved from low to medium and high. There was no change in the control group.

In the case of intergroup differences, in the post-test it was found at the level of statistical trend that the percentage of students with high scores in the experimental group increased (from 6.25% to 31.35%) compared to the control group (0.00% in both measurements; $\chi^2 = 5.03$; $p = 0.081$). No intergroup differences were found in the pretest ($\chi 2 = 1.52$; $p = 0.468$). The discussed results are presented in Table 2 and Figure 1.

Table 2
The level of convergent thinking depending on the type of group and measurement

Group	Level of thinking	Pretest		Posttest	
		N	*%*	*N*	*%*
Control	Low	8	72,73%	6	54,55%
	Medium	3	27,27%	5	45,45%
	High	0	0,00%	0	0,00%
Experimental	Low	13	81,25%	8	50,00%
	Medium	2	12,50%	3	18,75%
	High	1	6,25%	5	31,25%

Source: Author's research.

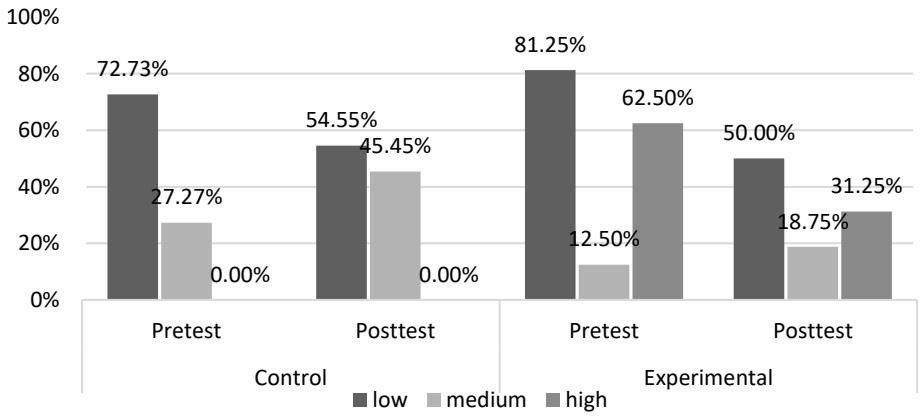

Figure 1
The level of convergent thinking depending on the type of group and measurement
Source: Author's research

As for individual indicators of convergent thinking, the data are included in Table 3 and in Figures 2-3.

A statistically significant increase in the level of sematic implications was noted in the experimental group when comparing the pretest and posttest (p = 0.029). In addition, in this group, an increase in the level of semantic classes (p = 0.082) and symbolic implications (the sign change test) (p = 0.074) was also found at the level of statistical tendency. Therefore, an increase in the result of the total convergent implication production (p = 0.073) was recorded at the level of the statistical trend. In all cases, the strength of the effect was high (r > 0.50). No statistically significant changes were found in other indicators of convergent thinking.

Table 3
Comparison of pretest and posttest in convergent thinking in an experimental group

Experimental group			Pretest		Posttest				
			M	*SD*	*M*	*SD*	*With*	*p*	*r*
Converging Class Generation	Semantic classes	P1	0,88	1,09	2,09	2,37	-1,74	0,082	0,66
Converging system manufacturing	Symbolic Systems	P2	2,13	1,20	2,38	1,20	-0,82	0,414	0,82
	Semantic systems	P3	0,88	0,34	0,88	0,34	0,00	1,000	0,81
		P4	1,44	0,81	1,50	0,82	-0,29	0,773	0,67
		P5	1,38	1,28	1,88	1,41	-1,03	0,301	0,65
		Including	3,69	1,99	4,25	2,14	-0,76	0,449	0,36
	Including		5,81	2,98	6,63	3,18	-0,86	0,392	0,30
Converging transformation generation	Symbolic transformation	P6	1,00	1,21	1,94	1,88	-1,61	0,107	0,68
Converging Implication Manufacturing	Symbolic implications	P7	1,00	1,03	1,00	1,03	0,00	1,000	0,65
		P8	0,75	0,88	1,50	0,89	-1,79	0,074#	0,66
		Including	1,75	1,40	2,50	1,55	-1,52	0,128	0,62
	Sematic implications	P9	0,69	0,79	1,38	0,72	-2,18	0,029*	0,72
	Including		2,44	1,64	3,88	2,09	-1,79	0,073#	0,57
Total			10,13	5,48	14,53	7,61	-1,35	0,179	0,34

Source: Author's research.

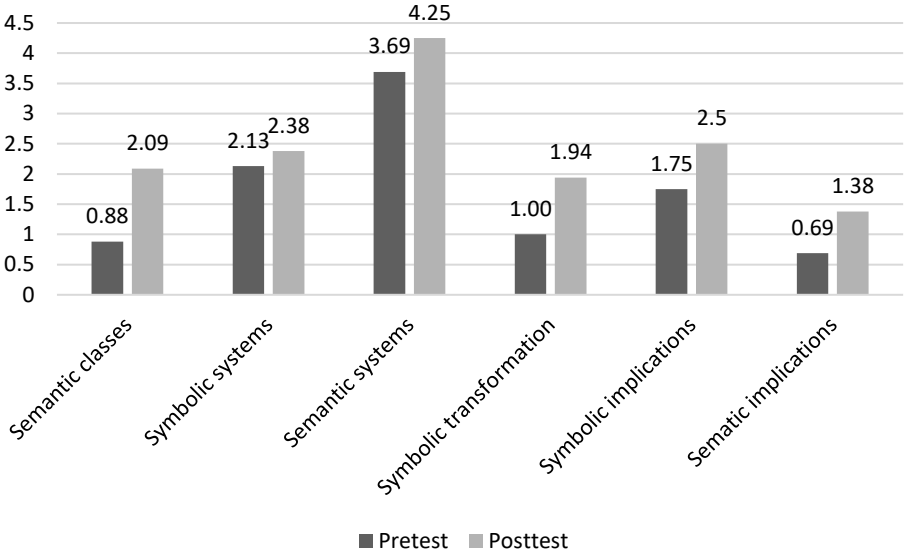

Figure 2
Comparison of pretest and posttest in the field of subareas of convergent thinking in the experimental group
Source: Author's research.

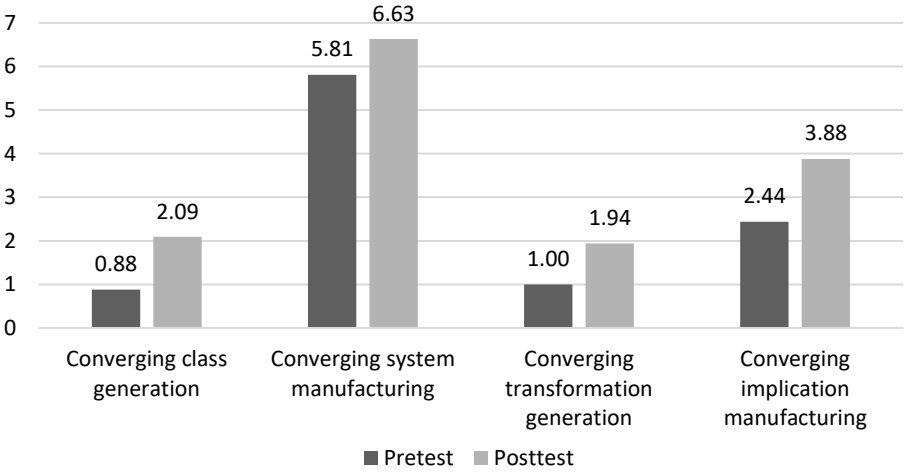

Figure 3
Comparison of pretest and posttest in the field of convergent thinking areas in the experimental group
Source: Author's research.

Summary and Conclusion

In the context of the research question about the effectiveness of mind maps in the development of convergent thinking, it should be stated that the intervention applied in the experimental group contributed to an increase in the percentage of students reaching a medium and high level, which was not the case in the control group. These results indicate promising effects, although they need to be confirmed in subsequent studies.

Referring to verification problems, the implemented activities – mind maps – in the experimental group contributed to a significant increase in the level of semantic implications and a tendency to improve indicators related to symbolic implication and convergent class production. The influence of other factors (disturbing variables) should be noted, e.g. the teacher's influence, the child's learning style.

The validation of the test constructed by the author to measure the level of convergent thinking of second-graders confirmed its reliability and usefulness. It is suitable for the intended use.

It is worth noting the low initial level of convergent thinking in students in both groups. The students had a problem with the tasks they were supposed to do. This indicates the need to develop this type of thinking at the stage of early school education. According to Guilford's (1978) assumptions, much depends on memory resources, because convectional operations require the generation of new information from already known information.

One of the ways that teachers can use, as the results of research show – creating notes in the form of mind maps. Therefore, there is a need to implement mind maps in primary schools starting from grades 1-3. It is worth it for teachers to learn the principles of creating mind maps according to T. Buzan and encourage students to use them. The discussed issues require further research to learn about the impact of mind maps on the level of convergent and divergent thinking. According to Guilford (1978), "in everyday life, these two types of production are not distinguished; People very often use divergent manufacturing to a large extent in order to find a convergent response" (p. 413).

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Mapy myśli i myślenie konwergencyjne uczniów drugiej klasy – raport z badania pilotażowego

Streszczenie

Artykuł podejmuje temat wykorzystania map myśli jako narzędzia wspierającego rozwój myślenia konwergencyjnego u uczniów klasy drugiej szkoły podstawowej. Przedstawiono teoretyczne podstawy map myśli według Tony'ego Buzana oraz wyniki badań potwierdzające efektywność tej techniki notowania. Opisano również kwestie związane z myśleniem konwergencyjnym w ujęciu J.P. Guilforda. Efektywność map myśli sprawdzono z zastosowaniem *quasi*-eksperymentu. Badanie miało charakter pilotażowy, mający na celu walidację testu – narzędzia badawczego. Skonstruowany test poziomu myślenia konwergencyjnego uwzględniał wskaźniki podane przez J.P. Guilforda: wytwarzanie klas, wytwarzanie systemów, wytwarzanie przekształceń i wytwarzanie implikacji. Wyniki wykazały, że na początkowym etapie w obydwu grupach – eksperymentalnej i kontrolnej – poziom u większości uczniów był niski. Po cyklu zajęć z wdrożenia map myśli w grupie eksperymentalnej zwiększyła się liczba uczniów ze średnim i wysokim poziomem myślenia konwergencyjnego. Odnotowano również pozytywne zmiany w zakresie wytwarzania implikacji semantycznych. Zmiany te, choć częściowo istotne statystycznie, wskazują na potencjał tej metody w rozwijaniu myślenia konwergencyjnego u uczniów. Warto zatem wdrażać mapy myśli w edukacji wczesnoszkolnej oraz rozszerzyć badania w tym zakresie.

Słowa kluczowe: mapy myśli, myślenie konwergencyjne, uczniowie, edukacja wczesnoszkolna.