THE STEAM APPROACH IN PRE-SCHOOL EDUCATION - INVESTIGATING THE CRITICAL THINKING SKILLS OF CHILDREN IN THE KINDERGARTEN PREPARATORY GROUP

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Abstract

The skill of critical thinking develops from early childhood, in the sensorimotor and preoperational periods defined by Piaget and continues throughout human life. If, however, there is a possibility of the absence of stimuli (game tools, methods, approaches, materials, techniques and technologies) developing criticality, during the most active cognitive period of the child's personality, there is a risk of loss and inability to develop this so important a skill for the future. Given that the skill of critical thinking does not appear automatically when a person reaches adulthood, it must be nurtured and taught during the early stages of childhood development, through STEAM education. The present study aims to show, by solving a case study of children in a group where STEAM learning is applied and solving the same case study of children in a group where a STEAM approach is not applied, whether the use of the interdisciplinary approach in the preschool institution develops or not critical thinking skills in children.

Keywords: *problem situation, holistic development, constructivism, interpretation, explanation, evaluation, inference, analysis, self-regulation*

Introduction

The great John Dewey argued that no one can think about something they have no experience with [1]. Children acquire their knowledge and skills in the material and immaterial world that surrounds them, which is why the organization of the interior and exterior of rooms and buildings is important. Also important is the example, attitude, behavior, verbal and nonverbal communication with which the child is in constant contact. Another important principle in his theory is the well-known "learning by doing", [2] because he compares learning with research, which in turn becomes an experience that encourages the child to think critically, the first steps towards STEAM education. John Dewey was also an innovator in including the phrase "critical thinking" in pedagogical science. According to research by Vakleva and Georgieva, the term appeared when Dewey was faced with another formulation of an educational goal in his work, a concept that to this day attracts the attention of specialists from all over the world [3].

As a result of numerous global and national studies, one of which is by the Bulgarian Kostova (2017), who studies the development of the brain and its role in the formation and development of critical thinking in the child's personality. The researcher found that the most favorable period for the formation of critical thinking skills has a biological predetermination and depends entirely on the stimuli of the environment (material and immaterial) during the period of brain development, respectively, and thought processes.

The preoperational stage from 3 to 7 years of age has the characteristic of natural cognitive activity and is a factor in the generation of brain circuits, in the formation of which lies the formation of synaptic connections, according to Kostova (2017), *„The metabolic activity of the brain is highest at the end of the 3rd year - twice as high as that of an adult. Until the end of the 9th year, it remains high and then begins to decrease until it stabilizes at the end of adolescence. Experience, i.e. learning between the 3rd and 20th years, sculpts the brain... Synaptic connections that are not used until the 9th and 10th years are slowly removed"* [4]. Therefore, by the ninth year, the maximum amount of stimuli for the formation of synaptic connections must be created, which in turn will lay the foundations of critical thinking.

The catalysts for critical thinking skills are diverse and combine traditional (conversation, etc.) and non-traditional (case study, narrative method, etc.) approaches and methods of interaction with children in the preschool educational institution, as well as innovative approaches such as STEAM, in which knowledge is formed on the basis of skill. The STEAM approach meets the needs of the

modern generation of “learning by doing” [5], research, analysis and independent access to new knowledge, which remains permanent due to physical activity, tactile interaction with the environment, developing sensorimotor and motor skills, and as a result, cognitive processes. The inclusion of all senses in children's project or game activities is a guarantee of high-quality and effective, multifaceted children's physical, mental, emotional, spiritual-moral, intellectual and social development [6].

However, the most important thing is the formulation of a specific goal, as a result of which the means for the implementation of this goal are determined and selected. When the pedagogical specialist realizes the functionality of analysis, generalization, interpretation, conclusions, evaluation and self-regulation, and the need of society for critically thinking individuals, he begins to explore the topic, to improve his qualifications in order to become a competent adult who adequately and purposefully develops one of the principles of the 21st century - the principle of critical thinking [7].

The combination of purposeful organization of the educational environment, methods, approaches, means, strategies and a motivated, with well-developed critical thinking skills, specialist and/or adult creates an environment for the fundamental skills of critical thinking.

Materials and Methods

As a result of the researched scientific literature on the topic, the author of the report's desire to investigate the critical thinking skills of preschool children and their multiplication in the innovative STEAM approach emerged. The goal is to make a comparative analysis between the critical thinking skills of children aged 6-7, in whom the STEAM approach is applied, twice a week, through additional pedagogical situations specified in Regulation 5 on preschool education [8] as permissible above the total minimum weekly number, and the critical thinking skills of children who have not formed knowledge and skills through the holistic approach. Basically, the idea is dictated by the intensive introduction of STEAM into the educational system in our country and it is appropriate to establish the influence of the constructivist approach on the formation and development of 21st century skills.

The subject of the study is the influence of the STEAM approach on the formation of critical thinking skills in children aged 6-7.

From the thus formulated goal and subject, the object of the study is derived, which is the critical thinking skills in children aged 6-7, integrated into the STEAM approach.

The tasks set by the author of the report are:

1. Analysis of the literature and conclusions of other researchers on the topic of critical thinking in children and the application of the STEAM approach in the preschool institution.
2. Survey and selection of tools for studying critical thinking in children aged 6-7.
3. Adaptation of the selected tools and preparation of the diagnostic didactic sheet as a tool for assessing and supporting the processes of child development, which contains a case study designed to diagnose children's critical thinking skills.
4. Formulation of letters of invitation to the Directors of kindergartens to participate in research activities.
5. Creation of informed consent for the parents with whose children the study will be conducted.
6. Conducting the diagnostic procedure.
7. Comparative analysis of the results of the study.
8. Formulation of conclusions from the study.
9. Preparation of thank-you addresses to the Director and teachers of the groups that took part.

As a result of the tasks, a research hypothesis was formulated, which states that if a comparative analysis of critical thinking skills is made in children aged 6-7 from two different kindergartens, one of which has applied the STEAM approach for two years, and the other has not yet established it as an interactive approach for interacting with children, the influence of the holistic approach on the development of critical thinking skills will be established, and this fact, in turn, will lead to the

presentation of convincing arguments for the influence of STEAM on the child's personality and its preparation for the professions of the future.

The methods of this study are:

− Pedagogical observation
− Didactic test
− Comparative analysis

Instrumentation:

− Letter of request
− Informed consent
− Test case

The scope of the study included 10 children from the “Stara Zagora” preschool, of which 7 girls and 3 boys, in whom the STEAM approach has not yet been applied. And 10 children from the “Kazanlak” preschool, 4 girls (40%) and 6 boys (60%), in whom the constructivist approach has been applied for two years, as shown in Table 1. The study was conducted during non-school time (June), when the children were distributed into different age groups of 5 children per group, which facilitated the selection of children from kindergartens. In the “Stara Zagora” preschool, there were also three children aged 6-7 distributed into the other age groups, but they were not studied - the researcher focused only on groups of 5 children from the groups prepared for school.

Table 1 Gender distribution of children from the two kindergartens

working group	**gender**					
	boys		girls		Total	
	n	**%**	**n**	**%**	**n**	**%**
KINDERGARTEN „Stara Zagora“	7	70	3	30	10	100
KINDERGARTEN "Kazanlak"	6	60	4	40	10	100
Total**:**	13	130	7	70	20	200

Criteria are critical thinking skills.

Indicators are:

- Able to analyze a situation – makes an analysis and synthesis of a case, creating connections between the individual parts of the whole and establishes the situation by providing evidence in favor of their statements
- Able to draw conclusions – formulate conclusions
- Can interpret – recreate emotions, moods, show empathy
- Makes an assessment of the situation
- Demonstrates the ability to self-regulate behavior, expressing the emotions of the participants in the case

As some of the most preferred and proven effective and correct tools for measuring critical thinking are specialized tests, problem-solving tasks, interviews, project activities, which also include STEAM activities, discussions, interviews and case studies, which are the basis of this study.

The criteria and indicators are evaluated through point indicators, shown in Table 2:

Table 2 Points and conditions under which they are placed

Points	Conditions under which the corresponding number of points is placed
0	There is no answer (cannot answer the question).
1	Expected and/or common answer (answer given more than twice).
2	Non-standard and/or rare answer (answer indicated up to twice or not indicated by any child)

For the purposes of this study, various ready-made, developed and verified instruments for measuring critical thinking in adults and children are studied, such as the Watson-Glaser Critical Thinking Appraisal (WGCTA), the Cornell Critical Thinking Test (CCTT), the Test of Everyday Reasoning (TER), the test for measuring critical thinking of students by Penka Kozhuharova [7], etc. In this case, the author focuses on a previously adapted and modified for the needs of the study case study from the dissertation work of Yaralı, Kevser Tozduman [9], [10], which examined children aged 5-7 years using a case study and questions to it that had previously undergone expert evaluation and been approved by habilitated persons. In addition, for her doctorate, Yaralı conducted a reliability and validity test of the test on five times more children (202) than the children in her study – over 40, in order to establish the quality of the formulated case study and the questions to it, as well as the narrative method, anecdotes and other tools that she included in her study. The case study explores the relationship between a current phenomenon and everyday life within a limited system. The case study is used to reveal children's critical thinking skills. The adolescents from the Kazanlak Primary School and the children from the Stara Zagora Primary School, as well as the observation technique, are key to this study. Observation is the main method of data collection and, in combination with various analyses of the case study responses, offers a comprehensive interpretation of the unconventional method. The collected data are analyzed qualitatively and quantitatively, taking into account the skills of interpretation, explanation, inference, evaluation, analysis and self-regulation, described by Facione (1990), depicted in Figure 1 as critical thinking skills [11], and the case study is fully consistent with the sub-dimensions (skills) of critical thinking.

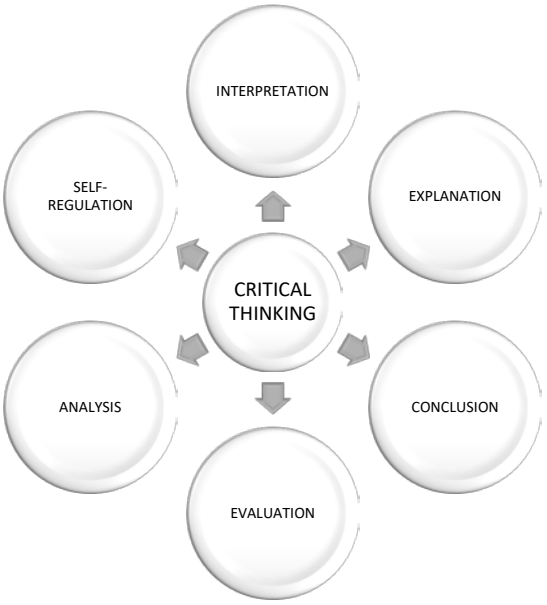


Figure 1 Critical thinking skills according to Facione

The researcher translates and adapts the content to the current conditions and age characteristics of the children to whom it will be applied. After that, an informed consent form is created, requiring completion by the parents of 20 children from both kindergartens. A didactic diagnostic sheet is formatted with fields for demographic and personal information for each of the respondents in the group and fields with the presented case, the questions to it and the assessment of skills. After obtaining consent from the parents, the study of the children begins and conclusions are drawn after a qualitative and quantitative analysis of the data. From Tables 2 and 3 it is clear that the maximum number of points for answering each question is 2 points, provided that there are 3 questions, then 2(points)*3(questions)=6 points is the maximum number for all answers of one child, the minimum is 0 points, as the sum of the points of the answers to the three questions, and the golden mean is 3 points, as the sum of the answers to the three questions. The median is calculated using the formula,

where 3 and 4 are the two middle numbers of the series of numbers from 1 to 6 and after calculating their average value, the median is found - 3.5

$$\frac{3+4}{2} = \frac{7}{2} = 3{,}5$$

Table 3 Case study for measuring critical thinking in children aged 6-7.

Case study: The kitten went for a walk with its mother. They talked, laughed, and had fun along the way as they walked. However, during the walk, the kitten saw its favorite liver on the edge of the container and immediately went to eat it. After finishing the liver, it looked around but could not see its mother.		**ОЦЕНКА**		
		(0) (no answer)	*(1) (expected and/or common answer)*	*(2) (non-standard and/or rare answer)*
1. What do you think is the problem in this story?	Child's responses			
2. How do you think the kitten must have felt when he realized his mother was gone?	(explanation, evaluation, analysis)			
3. What do you think the kitten could do to find his mother?	Child's responses			

The study is conducted at a time when the group teachers consider that they can allow the researcher into the classroom, which is a well-known and calm place to present the case to the child, after which he is asked the above-mentioned three questions - the answers are recorded on a Diagnostic, didactic sheet - protocol, and the child will be marked only with the initials of the first letters of the name and surname.

Results and Discussion

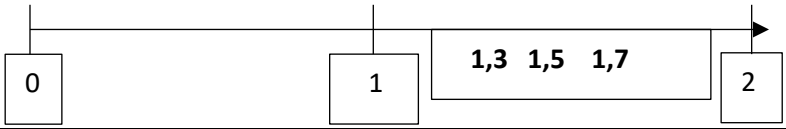
Analyzing the results of the case study of the Kazanlak Primary School in Table 4, it becomes clear that the total number of respondents aged 6-7 is 10 (VP, NH, ST, VD, AA, AK, IB, TH, ST, KK).

Table 4: Responses of children from the kindergarten "KAZANLAK"

What do you think is the problem in this story?		**assessment**	**How do you think the kitten must have felt when he realized his mother was gone?**	**assessment**	**What do you think the kitten might do to find its mother?**	**assessment**	**ball**
1. VP	The lost mother	1	It's sad	1	To look for his mother	1	3

2. NH	The kitten fell out of the container	2	It's sad	1	To look for his mother	1	4
3. ST	That the kitten was left alone	1	It's sad and crying	2	Conclusion: The mother must return to her child	2	5
4. VD	Conclusion: you shouldn't leave your mother	2	It's worried	2	To look for her mother or wait for her on a bench	2	6
5. AA	That the kitten didn't find its mother	1	It's surprised	2	To do a good deed	2	5
6. AK	That there was no liver for the mother cat either	2	It's sad	1	To look for her mother	1	4
7. IB	I don't know	0	It's guilty	2	Conclusion: It will be difficult to find her	2	4
8. TH	That the kitten didn't leave its mother's liver	2	It's lost	2	To look for her mother everywhere	1	5
9. ST	That the kitten was left alone	1	It's guilty	2	To go home and wait for her	2	5
10. KK	That the kitten couldn't find its mother	1	It's crying and sad	2	To look for her mother	1	4
Total points		**13**		**17**		**15**	**45/10**
Maximum points	10 children*2 points	20	10 children*2 points	20	10 children*2 points	20	
Average score - average score per child	13/10=1,3≈ 1 т.	1,3↑	17/10=1,7 ≈ 2 т.	1,7↑	15/10=1,5 ≈ 2 т.	1,5↑	**4,5**

If we assume that
0<1<2
So all the answers from 1,3; 1,5 and 1,6 are on the line between 1 and 2, which makes the answers positive



The frequency of responses to the first question, which reads: "What do you think is the problem in this story?", 5 children (VP, ST, AA, ST, KK) focused their attention on a problem related to the

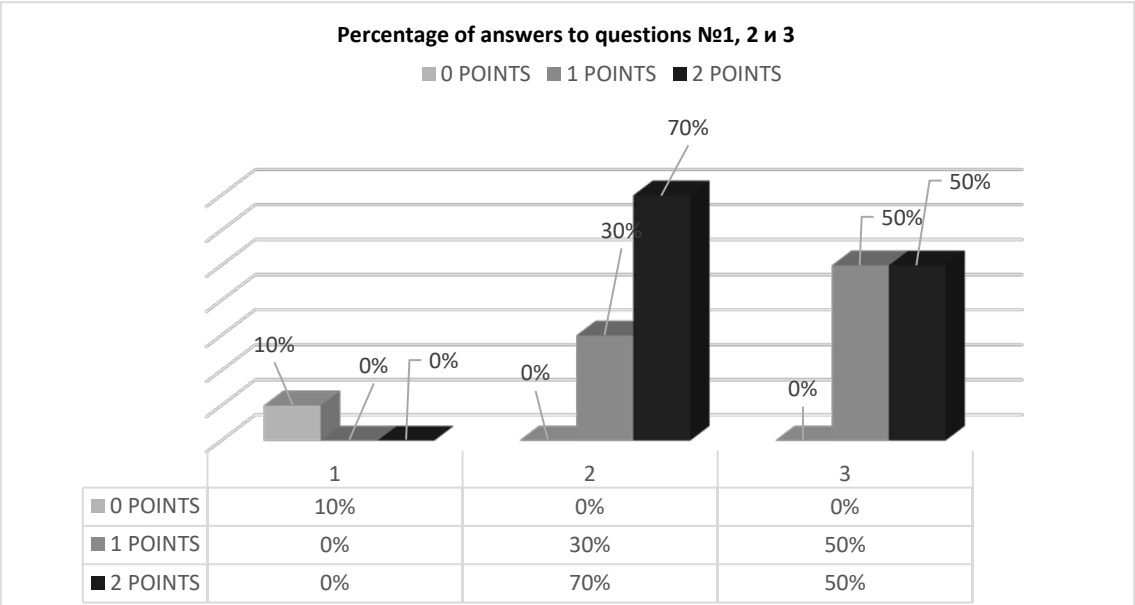


Diagram 1 Answers to the questions from the case study of children in the Kazanlak Kindergarten

loss of a loved one and this earned them 1 point each, because their answers were standard, common - more than twice, and some were incomplete; 2 children (AK, TH) focused on food and its tempting attraction, which earned them 2 points each - up to two identical answers and rare; 1 child (NH) noted a non-standard answer that the kitten fell out of the container and this was a problem because it got hurt, i.e. health is more important than the fact that the mother is not around, which earned the child 2 points, because such an answer has not been noted so far; another similar answer is the conclusion of child VD - you should not leave your mother - 2 points; 1 child IB is not aware of the problem and automatically receives 0 points, cannot identify what the problem is, probably doesn't know what the problem is. The child with 0 points is the only one in the entire case study who received 0 points for answering a question.

As visualized in Diagram 1, the most children from the group of those surveyed by the Kazanlak Primary School (50%) received 1 point, the least children (10%) - 0 points and 40% of all 10 children gave comprehensive and non-standard answers, as a result they received 2 points. From the total number of points (13) on the first question of all children, it is clear that this question receives the least number of points, and the average score per child is 1.3 points, which is approximately up to 1 point, compared to the other two: 17 - 1.7 points per child and 15 - 1.5 points per child, which are approximately up to 2 points - the average maximum value of the score per child.

A second question, aimed at the content of the case study: “The kitten went for a walk with its mother. They talked, laughed and had fun along the way while they were walking. During the walk, however, the kitten saw its favorite liver on the edge of the container and immediately went to eat it. After finishing the liver, it looked around, but could not see its mother” [10] is: “What do you think the kitten must have felt when it realized that its mother was gone?” most children – 5 (VP, NH, ST,

AK, KK) are of the opinion that the kitten is sad, as 3 (VP, NH, AK) of them received 1 point each, due to an incomplete and standard answer, and 2 child (ST, KK) establishes sadness, which he describes verbally with an additional verb such as “crying” and this provides them with 2 points each; 1 child (VD) – the kitten is worried and his statement carries 2 points, 2 children (IB, ST) note that it is guilty because it left its mother and indulged itself, that is – it only brought itself to this unpleasant end and no one is to blame for its choice and actions, as well as the consequences, and these answers give them 2 points; 1 child (AA) thinks that the kitten is surprised – 2 points, and another (TH) that it feels lost and alone, another 2 points for the team of highly rated respondents in the answers to this question.

The percentages of those who received 2, 1 and 0 points are shown in Diagram 1, from which it is clear that 0% failed to answer the Second Question, the largest number of complete, correct and comprehensive answers is 70% of the children surveyed, and 30% of the group received 1 point. From the total number of points received for the second question (17), it is clear that this question receives the highest number of points, and the average score per child is 1.7 points, which is approximately 2 points on average per child, compared to the other two: 13 and 15.

In the third question, "What do you think the kitten can do to find its mother?", 7 of the children at the Kazanlak Kindergarten answered that the kitten should look for its mother, which earned 1 point each. 5 of the respondents (VP, NH, AK, TH, KK) received 2 points for the seventh child (IB) for the complete and well-founded answer - a conclusion, and 4 children (ST, VD, AA, ST) focused their attention on other, non-standard solutions and actions, such as "the kitten should wait on a bench", "go to their own home and wait there", "do a good deed", as well as reaching the conclusion "the mother should return to her child", and these answers earned 2 points for each child.

Following the percentages from Diagram 1 to the third question, it becomes clear that all children answered positively and were distributed equally – 50% received 2 points and 50% - 1 point. On the third question, the total number of points (15) the average score per child is 1.5 points, which is approximately 2 points on average per child. And if we need to calculate the arithmetic average of a child from the Kazanlak Kindergarten, the average score is calculated using the following formula:

$$\frac{1{,}3 + 1{,}5 + 1{,}7}{3} = \frac{4{,}5}{3} = 1{,}5 \approx \mathbf{2}\ \boldsymbol{p}.\text{ per child}$$

Regarding the average score per child: 4.5 ≈ 5 points, one unit below the maximum score for the test: 6 points, which ranks the Kazanlak preschool, where the STEAM approach is applied, among those that have prepared and well-developed critical thinking skills in their children.

Table 4 is a basis for assessing children's critical thinking skills, revealing their ability to identify problems, express emotions and find solutions to specific problems. The predominance of answers related to loss and sadness indicate sensitivity and emotional intelligence, while the diversity in the proposed actions demonstrates the ability for logical and creative thinking.

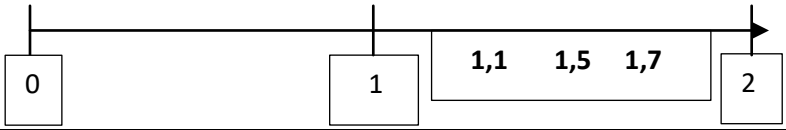
The analysis of the answers of children from the Stara Zagora preschool also includes ten respondents aged 6-7, with initials: DD, VD, PYa, DA, NK, TsH, NG, VS, NV, IM, as noted in Table 5.

Table 5: The responses of the children from the "STARA ZAGORA" preschool

What do you think is the problem in this story?		**assessment**	**How do you think the kitten must have felt when he realized his mother was gone?**	**assessment**	**What do you think the kitten might do to find its mother?**	**assessment**	**ball**
1. DD	The kitten is lost	1	Sad and scared	2	To look for his mother	1	4

2. VD	The kitten is lost	1	It's sad	1	To look for his mother with the help of another kitten	2	4
3. PYa	The kitten has lost its mother	1	It's sad	1	To look for his mother	1	3
4. DA	The mother is gone	1	Sad	1	To look for his mother by walking around and asking people where his mother is.	2	4
5. NK	His mother is gone	1	It's sad and alone	2	To look for his mother	1	4
6. TsH	The mother has come home	2	Worried	2	Interesting question: To go home	2	6
7. NG	That the kitten has lost its mother	1	It's sad	1	To ask someone about her, to sniff and look around	2	4
8. VS	That the kitten is lost	1	It's sad	1	To look for his mother and find her. He can also go home.	2	4
9. NV	That the kitten is lost	1	It's sad and it's crying	2	To go to the police	2	5
10. IM	The kitten is lost	1	Sadness and fear	2	To call 112	2	5
Total points		**11**		**15**		**17**	**43/10**
Maximum points	10 children*2 points	20	10 children*2 points	20	10 children*2 points	20	
Average score - average score per child	11/10=1,1≈ 1 т.	1,1↑	15/10=1,5 ≈ 2 т.	1,5↑	17/10=1,7 ≈2 т.	1,7↑	**4,3**

If we assume that
0<1<2
So all the answers from 1,3; 1,6 and 1,7 are on the line between 1 and 2, which makes the answers positive



9 children (DD, VD, PYa, DA, NK, NG, VS, NV, IM) focused their attention on a problem related to the loss of a loved one, the answer to which is based on which the children receive 1 point each, because the answers are identical, common - that the kitten got lost was noted by 4 children (DD, VD, NV, IM), the remaining 5 children connect the problem with the loss of the kitten's mother (PYa, DA, NK, NG, VS); 1 child (TsH) receives 2 points for his once-noted conclusion that the problem in the story is that the mother came home without her little kitten. There are no children without an answer to this question - with 0 points. As visualized in Diagram 2, the most children from the group of those surveyed by the “Stara Zagora” Kindergarten (90%) received 1 point, the least children (10%) - 2 points and 0% - 0 points. Calculating the total number of points (11) on the first question of all 10 children in the surveyed group, it becomes clear that this is the question with the fewest points, and the average score per child is 1.1 points, which is approximately to 1 point, compared to the other two: 15 - 1.5 points per child and 17 - 1.7 points per child, which are approximately to 2 points average score per child.

The next question, exploring the feelings of the kitten and the opinion of the children in the interpretation and manifestation of self-regulation in this question, 9 children (DD, VD, PYa, DA, NK, NG, VS, NV, IM) are of the opinion that the kitten is sad, as 5 (VD, PYa, DA, NG, VS) of them received 1 point each, because of the common answer that it is sad; and 4 children (DD, NK, NV, IM) found that in addition to being sad, the kitten is also "cowardly, alone, scared, crying" and this provides them with 2 points per child; the child TsH also receives two points because in his opinion the kitten is "worried", an answer that has not been noted so far by a child from this group. From the Kindergarten "Kazanlak", a child VD indicated this answer.

The percentages of those who received 2, 1 and 0 points are depicted in Diagram 2, where it can be seen that 0% failed to answer the question, 50% of the children received 1 point and the remaining 50% received 2 points, and the average score per child is 1.5 points, which is approximately up to 2 points on average per child, compared to the first question of 1.1, which is approximately up to 1 point.

Third question “What do you think the kitten can do to find its mother?” 7 of the children of the Kazanlak Kindergarten answered that the kitten should look for its mother, which brings 1 point to 5 of the respondents (VP, NH, AK, TX, KK) the seventh child (IB) was given 2 points for the complete and justified answer – conclusion, and 4 children (ST, VD, AA, ST) focused their attention on other, non-standard solutions and actions, such as “the kitten should wait on a bench”, “go to their own home and wait there”, “do a good deed”, as well as reaching a conclusion “the mother should return to her child”, and these answers bring 2 points to each child.

Following the percentages from Diagram 1 to the third question, it becomes clear that all children answered positively and were distributed equally – 50% received 2 points and 50% - 1 point. On the third question, the total number of points (15) the average score per child is 1.5 points, which is approximately up to 2 points on average per child.

And if we need to calculate the arithmetic average of a child's points and score from Kindergarten "Stara Zagora" it is calculated using the following formula:

$$\frac{1{,}1 + 1{,}5 + 1{,}7}{3} = \frac{4{,}3}{3} = 1{,}4 \approx \mathbf{1}\,\boldsymbol{p}.\,\text{per child}$$

Following the data from Table 5, the average score per child is 4.3, which is ≈ up to 4 points, two units less than the maximum number – 6 points.

Throughout the test, the high scores of child TsH were mentioned, who is the only one from the group of Kindergarten "Stara Zagora" with a maximum score – 6 points, in an identical way, from the group of Kindergarten "Kazanlak" there is one child VD, who has a maximum score – 6 points; child PYa has the lowest score from the entire group of "Stara Zagora" – 3 points, in parallel, a child VP from Kindergarten "Kazanlak" also has 3 points; the remaining children from both kindergartens have a score between 4 and 5 points, from Kindergarten "Stara Zagora" 6 children have 4 points, and 2 have 5 points each, and from Kindergarten "Kazanlak", 4 children have 4 points and the same number of children (4) have 5 points each.

In summary, combined in a common table 6, the results look as follows:

Table 6 Results from both kindergartens

	Kindergarten "Kazanlak"	**Kindergarten "Stara Zagora"**	**values**
points	2	1	**2 > 1**/ max – 2 т./ min – 0 т.
ball	5	4	**5 > 4**/ max – 6 бал./ min – 0 бал (сбор от максимален брой точки и на трите въпроса)

Analyzing the results and following Table 6, it is obvious that children who are using the STEAM approach give better results in studying the development of critical thinking skills than those who have not yet used this approach, although their results are not low, but rather average, probably teachers apply other methods and approaches to develop one of the principles of education in the 21st century. Therefore, the hypothesis of the study is proven: STEAM inevitably affects the development of critical thinking skills in children and it is appropriate to apply it in pedagogical practice for higher and better results, corresponding to all national and global educational trends.

Table 7 Mann-Whitney statistical test for both samples

Sample Kindergarten "Kazanlak"	**Sample Kindergarten "Stara Zagora"**	**Rank (Sample 1)**	**Rank (Sample 1)**	**n1**	**10**
3	4	1.5	7.5	n2	10
4	4	7.5	7.5	n	20
5	3	15.5	1.5	Mdn1	4.5
6	4	19.5	7.5	Mdn2	4
5	4	15.5	7.5	R1	74.5
4	6	7.5	19.5	R2	58.5
4	4	7.5	7.5	U1	80.5
5	4			U2	96.5
5	5				
4	5				

	U	**80.5**	<<< If U>Ucrit we assume they are the same, otherwise they are different. Ucrit is taken from the table of critical values.
	z-value	2.30558329	<<< For larger samples where there is no table of critical values, compare with 1.96
	Result	**H1:Various**	

In order to prove the presence or absence of a significant difference between the two samples, through statistical data processing, the researcher applies the Mann-Whitney statistical test for the two samples, Kindergarten "Kazanlak" with size n1=10 and Kindergarten "Stara Zagora", with size n2=10, with the purpose of using this data processing being a comparison of hypotheses, as shown in Table 7.

Table 8 Rank values of the two groups

Group	Value	Rank
Kindergarten "Kazanlak"	3	1.5
Kindergarten "Kazanlak"	4	7.5
Kindergarten "Kazanlak"	5	15.5
Kindergarten "Kazanlak"	6	19.5
Kindergarten "Kazanlak"	7	10.5
Kindergarten "Kazanlak"	8	10.5
Kindergarten "Kazanlak"	9	10.5
Kindergarten "Kazanlak"	10	10.5
Kindergarten "Kazanlak"	11	10.5
Kindergarten "Kazanlak"	12	10.5
Kindergarten "Stara Zagora"	4	7.5
Kindergarten "Stara Zagora"	5	15.5
Kindergarten "Stara Zagora"	6	19.5
Kindergarten "Stara Zagora"	7	10.5
Kindergarten "Stara Zagora"	8	10.5
Kindergarten "Stara Zagora"	9	10.5
Kindergarten "Stara Zagora"	10	10.5
Kindergarten "Stara Zagora"	11	10.5
Kindergarten "Stara Zagora"	12	10.5
Kindergarten "Stara Zagora"	13	10.5

After the data of the two samples are arranged and the ranks of each of them are calculated, as shown in Table 8, the sum of the ranks for each of the samples is calculated as follows:

− Sample 1 (Kindergarten "Kazanlak"): R1=74.5R1 = 74.5R1=74.5

− Sample 2 (Kindergarten "Stara Zagora"): R2=58.5R2 = 58.5R2=58.5

The U statistics (U1=80.5 and U2=96.5), then compare the U values with the Ucrit critical value from the Mann-Whitney table of critical values and take the smallest U value, in this case 80.5, where if the sample size is large enough, we can use a normal distribution to determine the Z-score. Compare the U value with the Ucrit from the Mann-Whitney table of critical values and those from Table 8 for n1 = 10 and n2 = 10. If U<UcritU < UcritU<Ucrit, we reject the null hypothesis (H0).

Since 80.5 > 27, this in itself suggests that there is no significant difference between the two samples. But when calculating the Z-score, we get: Z=2.305Z= 2.305Z=2.305

Comparing this value to the critical Z-score (usually 1.96 for a significance level of 0.05) shows that 2.305 > 1.96, which means that we reject the null hypothesis (H0). As a result, we accept the alternative hypothesis (H1) that there is a significant difference between the two samples.

In conclusion, we can say that the Mann-Whitney test shows that there is a significant difference between the critical thinking skills of children in the Kazanlak Kindergarten, where additional STEAM activities are carried out in the daily routine of the preparatory group, and the critical thinking of children of the same age in the Kindergarten "Stara Zagora". Therefore, we can conclude that the conditions, methods and approaches to learning applied in these kindergartens lead to different results in the observed indicators. In addition, it is important to note for practice that it is necessary to integrate the STEAM approach into the daily work of pedagogical specialists in kindergarten in order to prepare children for the professions of the future and adhere to the principles of 21st century education (critical thinking, creativity, communication and cooperation).

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