Logical-mathematical game in the context of early education. A study about the Romanian preschool teachers

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ABSTRACT

In this paper, we intend to provide explanations for the fact that logical-mathematical games (a teaching method in which simulated procedures prevail and its goals are to build the capacity to understand the causal relations between actions and events, to develop logical reasoning, and to perform operations and logical deductions) have a lower recurrence in current educational activities, although their importance is well known. We have studied the hypothesis of a dependence between experience and use of the logical-mathematical game in daily teaching activities, the hypothesis that the teacher who has already used logical-mathematical games is more flexible in adapting a teaching game to become a logical-mathematical game, the hypothesis of teachers who have already used logical-mathematical games being more willing to apply this type of game to a wider variety of target groups, the hypothesis that there is a direct connection between a teacher's past experience with logical-mathematical games and his/her willingness to use a variety of resources and high professional standards in planning them. The research provides statistically significant evidence suggesting that only teachers with less experience/seniority in education appear more interested in using logical-mathematical games in daily teaching activities, and teachers who have experience with logical-mathematical games rely more on that very experience in planning teaching than on specialist reference. Additionally, educators with little interest in teaching mathematics itself had low capacity to do exercises that involve a high effort in teaching and limited willingness to conceive, design and implement complex projects.

KEYWORDS

Logical-mathematical games, logical reasoning, operations and logical deductions, recurrence of logical-mathematical games in daily educational activities

RÉSUMÉ

Dans cet article, nous avons l'intention de fournir des explications sur le fait que les jeux logico-mathématiques (méthode d'enseignement dans laquelle les procédures simulées prévalent et dont l'objectif est de renforcer la capacité de comprendre les relations causales entre les actions et les événements, de développer un raisonnement logique et effectuer des opérations et des déductions logiques) ont une moindre récurrence dans les activités éducatives actuelles, bien que leur importance soit bien connue. Nous avons étudié l'hypothèse d'une dépendance entre l'expérience et l'utilisation du jeu logico-mathématique dans les activités pédagogiques quotidiennes, l'hypothèse selon laquelle l'enseignant qui a déjà utilisé des jeux logico-mathématiques est plus souple pour adapter un jeu pédagogique afin de devenir un système logico-mathématique. L'hypothèse selon laquelle des enseignants ayant déjà utilisé des jeux logico-mathématiques seraient plus disposés à appliquer ce type de jeu à une plus grande variété de groupes cible, l'hypothèse selon laquelle il existe un lien direct entre l'expérience passée d'un enseignant en matière de jeux logico-mathématiques et sa volonté d'utiliser une variété de ressources et de normes professionnelles élevées pour les planifier. La recherche fournit des preuves statistiquement significatives suggérant que seuls les enseignants moins expérimentés/ayant moins d'ancienneté en éducation semblent plus intéressés par l'utilisation de jeux logico-mathématiques dans les activités d'enseignement quotidiennes, et que les enseignants ayant une expérience des jeux logico-mathématiques s'appuient davantage sur cette expérience même de la planification de l'enseignement. De plus, les éducateurs peu intéressés par l'enseignement des mathématiques en tant que tel n'ont guère la capacité de faire des exercices qui exigent un effort d'enseignement élevé et une volonté limitée de concevoir et mettre en œuvre des projets complexes.

MOTS-CLÉS

Jeux logico-mathématiques, raisonnement logique, opérations et déductions logiques, récurrence des jeux logico-mathématiques dans les activités éducatives quotidiennes

Introduction

Mathematics in preschool

The early literacy researchers who investigated the longitudinal associations between early skills and later development (Aunola, Leskinen, Lerkkanen & Nurmi, 2004; Duncan

et al., 2007; Jordan, Kaplan, Ramineni & Locuniak, 2009; Siegler et al., 2012; Geary, Hoard, Nugent & Bailey, 2013) proved that children's early mathematical skills produce sizable effects on their much later math achievement, if they participate in some effective ways to increase children's math achievement in preschool; for example, Doug Clements's and Julie Sarama's early math curriculum (Clements et al., 2011). It is proved that sometimes knowing one mathematical principle can help children learn another. This phenomenon is known as learning transfer and has been demonstrated in many studies of children's math learning (Siegler & Ramani, 2009).

Define and characterize the game

The game is a specific human activity, dominant in childhood, which is initially linked to the sacredness and which, as a form of educational activity, is determined by the specific activities of unludic human essence such as creation, learning, work. "For the child, almost any activity is playing" (Chateau, 1970), because "the game is work, kindness, duty, it is the only atmosphere in which his psychological being is able to breathe and, in consequence, may act" (Claparède, 1946).

The game has formative valences, restructuring the entire psychological life of the child, because through play, children develop perceptions, representations, creativity, expand their memory strength, build their volitional qualities: patience, perseverance, self-control and shape their personality traits: respect for others, responsibility, honesty, courage (Barbu, Popescu & Şerban, 1993).

Didactical game

The didactical game is a method of education in which simulated teaching activity prevails, realising at the instruction level the adaptive finalities of recreative type, specific to human activity in general, in certain moments of its ontogenetic evolution, especially that enhances the action of teaching through ludic incentives which are subordinated to the purpose of teaching learning assessment in a strong formative perspective (Bocoş, 2002). Children's experiences shape their motivation or approaches to learning (one of five aspects of school readiness (Kagan, Moore & Bredekamp, 1995), and conversely, these dispositions and behaviours affect their learning and development. Mathematical games aim at developing mathematical abilities through activities that involve identifying, representing and composing shape (Chinese puzzle - Tangram), transformations, measurement or patterning.

The logical -mathematical game

The logical and mathematical game goal is to build capacity to develop judgment, to act on the basis of rules and principles with logical operators, to ensure premises for internalising operations that were derived from the action with objects in the context of the teaching experience within the directed pedagogical process (Petrovici, 2014).

The mental act is formed through a process of gradual internalization of the action with proper objects, after the *galperian* (Galperin, 1982) route for the mental training action: perception → representation → verbalization→ internalization of action (action is explained in the external language plan to himself) → internalization of language.

The teaching approach, in the context of early education, from the process of routing the action of interiorization includes the following steps: orientation to the didactic task, guided learning, verbalization of action, internalization of action and endophasia (Fischbein, 1970).

Therefore, the didactical logical-mathematical game must be well considered, starting with the plan, in order to structure correctly all the stages of the game, depending on the purpose, the mathematical content and the instructional sequences (aiming at matching the lesson sequences with the play stages: the lead-in / introduction into the game, the presentation of the aims and objectives / the game introductions, revising previous knowledge / revising content, the presentation of content and giving instructions / the illustration of the game, the consistent performance and ensuring the feedback / game course, ensuring retention and transfer / complicating the game, the assessment of the performance / the conclusion of the game), so as to design attractive didactic tasks and elements of the game, using a varied and attractive appropriate teaching demonstrative and distributive material [for example: Dienes kit which contains three main geometric figures (rectangle, square, triangle, circle) in three different colors, two sizes (large, small) and two thicknesses (thick, thin)] (Dienes & Golding, 1970).

In the stage of introducing the new game, the teacher must have in view to catch all the children's attention, to correctly interpret all the tasks of the game and to effectively involve the children into the game. This implies using mathematical discourse such as modeling and thinking out loud, following four steps: understanding the question, choosing a strategy, using the strategy and checking the answer. The role of the logical-mathematical game is to help the child understand the structural, functional or causal relations that he/she meets in real life situations.

The goals of the logical-mathematical game

The goals of the logical-mathematical game are understanding the causal relations (if ... then) between actions and events, developing logical reasoning, and performing operations and logical deductions.

This requires enabling the active memory, the comprehension ability and the discrimination between various concepts, based on the operation with genus proximus and specific difference (Carroll, 1897), the ability of making connections among the cognitive operational background knowledge.

If the types of tasks involved in mathematical games for making sets are of the type practicing skills of elementary mathematical (identifying objects, grouping, association

in pairs, sorting, ascending or descending ordering, classifying, assessing the overall amount), and the tasks involved in mathematical games for numeration are of the type practicing and developing counting skills (associating ordinal and cardinal element of a set, making a series of sets ordered by cardinal, composition and decomposition of numbers or subtracting operations by 1-2 units in concentric 0-10), then, the didactic tasks specific to logical and mathematical games are complex, such as practicing specific mathematical skills (notification of changes that occur in a quantity or drafting judgments and expressing logical units) and the type of practicing skills to use logical quantifiers (existential, universal) and logical connectors (negation, conjunction, disjunction).

Specific for the logical-mathematical game is the rigor in thought and in expression, so it is very important to use appropriate positive appreciation of the correct answer, and to correctly stimulate the incomplete / incorrect response, because the purpose of the educator is not to inhibit the child's reactions, but to encourage them, to provide opportunities for expression, to develop problem-solving strategies and to stimulate self-confidence (Schulman & Kolombus, 1998).

Examples of teaching tasks constructed in a logical-mathematical game

To optimize the performance strategies involved in logical-mathematical games, it is necessary to build specific tasks to the game content, to be different, gradually organized, structured from simple to complex, appropriate to each stage of the game (Seefeldt & Galper, 2004). In this context, the Venn-Euler diagram is a useful tool as it assures the construction of the visual image of the lots with which it operates, as well as the manipulation of Dienes pieces or toys used to build lots with the required properties. An example of this can be built in the following context: children have as distributive material the set of all squares from Dienes kit and two small thick, blue discs. Didactic tasks:

1. Form the set containing the small squares, and two thin disks of the material that you have.
Note 1: that in this formulation of didactic task, the word "and" has no logical sense, but an enumerative sense. A rigorous formulation should contain the word "or", because the logical sense is by disjunctive type.
Note 2: We must make the distinction between abstract set (containing only the generic elements and each distinct element can appear only once) and the concrete set (composed of tangible elements that are distinct pieces, even if they belong to the same category).

2. Build the set containing the large thin squares of material that you have.
Background: The teacher, without the children noticing, takes a small circle from the first set and moves it into the second set.

3. In which set of blocks are they located, the first or the second set?
Answer: The set containing all the thin squares of Dienes kit and two small discs, thick, blue.
Note: From the mathematical point of view, it is about the unit of two sets.

4. What is the set of blocks in which are found both in the first set and in the second set?
Answer: The set containing a small disc, thick, blue.
Note: From the mathematical point of view, it is about the intersection of two sets.

5. What is the set of blocks in which are located in the first set but not in the second set?
Answer: The set of small squares, thin.
Note: From the mathematical point of view, it is about the difference between the first and the second set.

6. What is the set blocks in which are located in the second set and are not located in the first set?
Answer: The set of large thin squares.
Note: From the mathematical point of view, it is about the difference between the second and the first set.

7. What is the set of blocks in which are located neither in the first set nor in the second set?
Answer: The set of thick squares.
Note: From the mathematical point of view, it is about the complementary to the union of initial sets in rapport with the blocks set from kit Dienes.

8. Are there thick blocks in the first set?
Answer: Yes, there are: the small, thick, blue disc.
Note: From the mathematical point of view it is about using the existential quantifier.

9. How is any square of the second set?
Answer: Every square of the second set is large, thin.
Note: From the mathematical point of view it is about using the universal quantifier.

10. What happens if from both sets we eliminate yellow and red squares?
Answer: Both sets will only have blue blocks.

11. What needs to be removed before new sets to become equal?
Answer: The squares of each set must be removed.

Materials and methods

Materials

Considered problem

In this study we intend to analyze and to establish the link between teachers' experience in pre-school, their predisposition to use didactical game in educational activities or their willingness to use the logical-mathematical game in mathematical or interdisciplinary activities.

Research goal

The research goal is to establishing the degree of influence of the teachers' experience in pre-school and their predisposition to use the didactical game in educational activities or their willingness to use the logical-mathematical game in mathematical or interdisciplinary activities.

Research objectives

1. Develop a statistical questionnaire.
2. Investigation based on a questionnaire in kindergartens in Iasi County.
3. Recording and analyzing the responses.
4. The level of influence that the teachers' experience has on the frequency of using logical -mathematical game in their current activity.
5. Establishing the link between frequency of use in current teaching the game and the willingness to use the logical-mathematical game.
6. Determination of influence of the use of logical-mathematical game on the quality of planning and development of mathematical teaching activities.

Research hypotheses

In this study, we aimed to study the following hypotheses:

1. There is dependence between a teacher's experience and the use of logical- mathematical game in the current activity.
2. A teacher who has used teaching games before is more flexible and willing to adapt a didactical game to become a logical- mathematical game.
3. The fact that a teacher has used didactical games before influences the willingness to apply logical- mathematical game to a wider range of target groups.
4. The fact that a teacher has used logical-mathematical games before influences his/her availability to use varied sources of high professional standards when designing these games.

The sample (group of subjects)

The group of subjects consists of 315 voluntary teachers from different kindergartens included in Iasi County, from both rural and urban areas, with an experience between 0 and 44 years. The sampling procedure used is the layered sampling with simple random selection, in which stratification variables are: kindergarten type (rural, urban) and the teaching experience. It was intended as a sample of teachers to be constituted as representative so as to faithfully reproduce the characteristics of the teaching population that has been selected, so MPE (maximum difference accepted between the value of a feature found in the sample and the corresponding found the population) should be below an acceptable limit, and the level of confidence (real chances that the error committed not to exceed the maximum permissible error) should be at least 95%.

The research design

The activity was held in November 2015 and targeted testing groups of teachers in rural or urban, in Iasi county, through questionnaires that have followed, depending on the educators' answers, the correlation between the teaching experience in pre-school and their predisposition to use didactical game in educational activities or their willingness to use the logical-mathematical game in mathematical or interdisciplinary activities.

Methods

Instruments

The questionnaire determining the interdependencies between the dependent variables studied (Appendix 1).

The experimental plan

At the time of testing, the experimental design used a single factor variation (operationalization of teaching by approaches of the logical-mathematical game type) and measurements of dependent variables: experience in education, target group, history, flexibility, information sources.

The methodology for conducting research

*The m*ethods used in this research are observation, questionnaire and analysis. The observation was conducted from the perspective of involvement in the business of solving questionnaire of the whole lot of subjects. As a descriptive method, the observation consists of accurately recording both the behavioral manifestations of the individual or group of elements and the situational context in which they occur. By planned and systematic observation of the entire lot, it was found that the subjects were interested in questionnaires proposed and demonstrated an attitude of collaboration, more or less enthusiastic, depending upon a variety of factors (curiosity, interest in a new activity, emulation created between them).

The observation generally took place systematically (intentionally designed for a certain behavioral field), but circumstantial elements also interfered when unexpected events have occurred, however they were considered relevant for the study. We mainly used direct observation (the observer is present and this is acknowledged by the subject as well), passive (the observer is not involved in the activity group) and as objective as possible (trying to eliminate elements that generate the halo effect (Thurstone, 1974).

The questionnaire aims to collect information at the level of involvement of teachers in the use of logical-mathematical games (depending on experience, the target group to which he is committed to implement the logical game, history of using the logical game in current activity, flexibility in adapting a teaching game to become logical game and sources of information used in designing the logical game) and it is conceived specifically, logically, preserving the character of a dialogue, representing a cognitive

and communicative coherent approach. The questioning did not disadvantage a priori any answer and nor did it indicate, by the implicit choice of words, the answer that most subjects would assume that must be given. Since the variants of response were not explicit, it was avoided "*the questionnaire effect*" (De Singly, Blanchet, Gotman & Kaufmann, 1992) due to the distortions resulting from the wording of those questions, caused by the propensity of the majority to give a legitimate answer.

In constructing the questionnaire, it was kept in mind that more important than standardization and testing of the items are the *fluency and internal consistency of the sequence of questions, as well as logical and content connection between a question and another*. In this regard, questions have been sequenced so as to eliminate "*the context effect*" (De Singly, Blanchet, Gotman & Kaufmann, 1992). The number of subjects who refused to respond to this questionnaire is below 1%.

All these corroborated results validate the instrument built and guarantee the efficiency of their utilization in this study.

The analysis is the general methodology of scientific research of a phenomenon through decomposition into blocks and thorough examination of the structure, composition, dependencies, and percentage of their concrete influences. The value of analysis increases with realization of comparisons that ensure the profoundness of the study conducted. Its goal was to optimize the results by combining intensive methods, which are performed on representative samples using *analytical methods* (observation, analysis) with those extensive, which are based on methods such as *survey based on questionnaire applied in panel studies*. By corroborating the results achieved after applying combined intensive and extensive methods, the conclusions of the research were formulated.

Research variables

Independent variable: Operationalization of teaching approaches of logical -mathematical game type.

Dependent variables: Experience, Target group, History, Flexibility, Information sources.

Operationalization of variables

Experience in education (What is your experience in education?):

No answer

- Between 0 and 4 years
- Between 5 and 9 years
- Between 10 and 14 years
- Between 15 and 19 years
- Between 20 and 24 years
- Between 25 and 29 years
- Between 30 and 34 years
- Between 35 and 39 years
- Between 40 and 44 years.

Target (Which pre-school groups are best suited for this type of teaching game?):
- All groups (elementary school K1-K3)
- Elementary school K2
- Elementary school K2, K3
- Elementary school K3 and preparatory class

History (Have you ever used this type of game teaching in your activity?)
- Yes
- No

Flexibility (Do you consider that a teaching game can be adapted to become logical-mathematical game?):
- Yes
- No
- Depends on the topic of activity
- I do not know
- Yes, because they have the same structure
- Yes, because they have the same goals

Information resources (What resources are you using for documentation when designing such an activity? A) auxiliary B) textbooks, C) websites D) others)
- Workbooks
- Textbooks, excerpts of games
- Sites on the Internet
- Specialty papers
- Curriculum for preschool education
- Didactic of mathematics teaching in preschool education
- Previous experience
- Examples of experienced teachers
- Methodological guides
- Training courses
- Diana Publishing House materials

Results and discussions

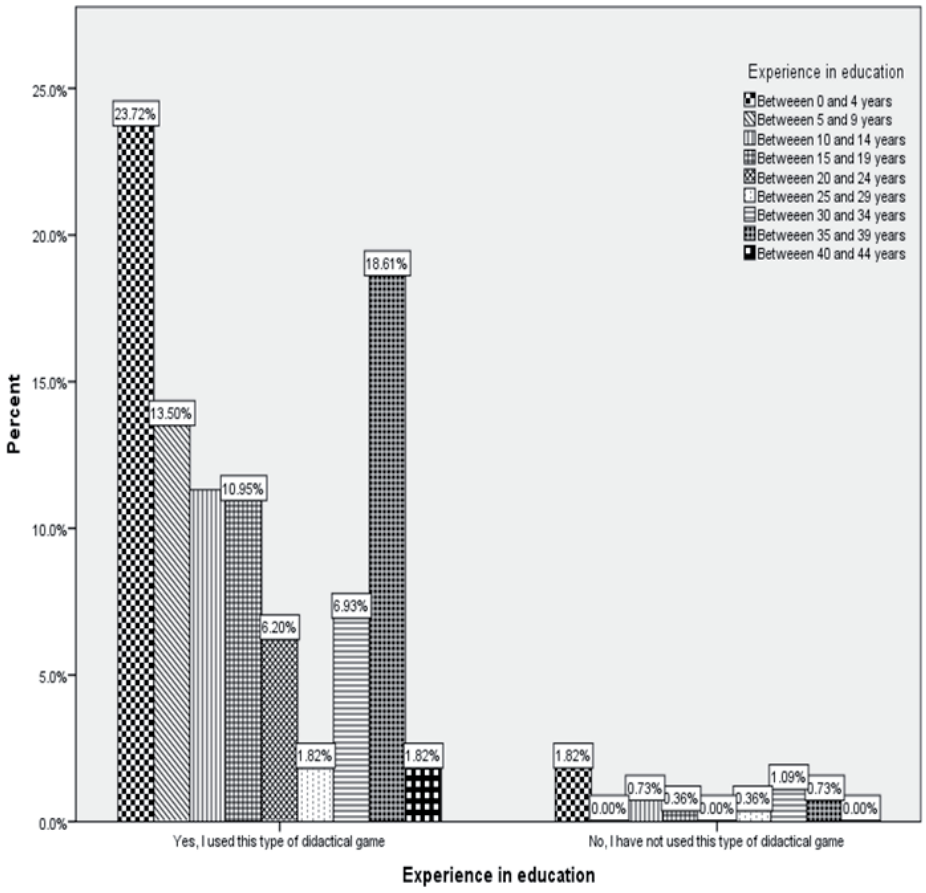
The analysis and the interpretation of the results related to each hypothesis of the study

1. There is a dependency between experience and the usage of the logical -mathematical game in the current activity.

Analysis of the histograms made based on answers given by teachers from the target group on the questionnaire reveals that the teachers with a reduced experience in edu-

cation seem to be more interested in using the logical-mathematical game in current activity (among respondents with experience between 0 and 4 years, which represents 23.72% of the total number of respondents, about 93% said they had used the logical game in teaching mathematics) (Figure 1).

FIGURE 1



The correlation between the experience/seniority in education and the history of using the logical-mathematical game in current activity

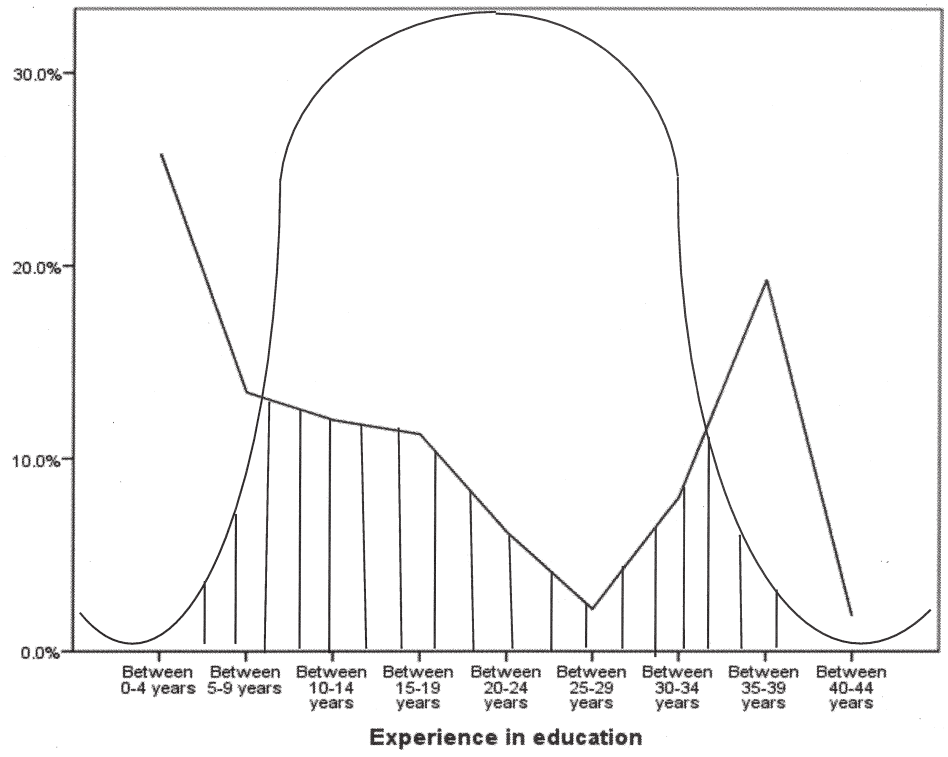
A critical analysis (such as communication theory) of the histograms from Figure 1. must be done taking into account that the measure of real information is the area of intersection (hatched) of the subgraph obtained by the representation made with the responses to the questionnaires and the subgraph of the bell Gauss (Shannon, 1948).

The Shannon-Hartley theorem establishes the Shannon channel capacity for

a communication link from the perspective of the maximum amount of error-free information per time unit that can be transmitted with specified bandwidth in the presence of noise interference, assuming the signal strength is limited, and that the Gaussian noise process is characterized by a known spectral power density. Concretely, in our case, assuming that the disruptions caused by various sources (internal: beliefs, personal desires, external: influences of entourage people) are represented by Gauss's bell, Shannon-Hartley's theorem asserts that real, undisturbed information is represented by the area between the sub graphic representation of teachers responses and the subgraph of Gauss's bell (Figure 2).

Therefore, we logically deduce that the game is not a tool to be used routinely. The positive responses obtained to this question seem to be rather the consequence of the tendency to comply with a legitimate answer.

Figure 2



The measure of real information

A teacher who used frequently logical games is more flexible to adapt a teaching game to become logical-mathematical game.

The Pearson correlations have demonstrated a low direct dependence between the history of teacher's teaching and his/her flexibility in adapting a game to become logical-mathematical game (Table 1).

TABLE 1

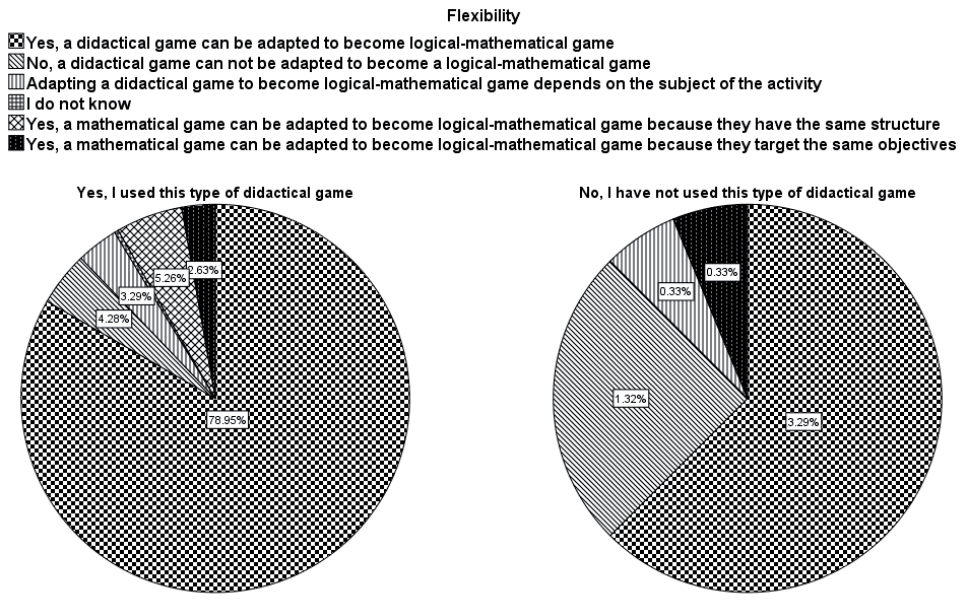
The Pearson correlation between seniority in education and flexibility to adapt a didactical game to become a logical-mathematical game

	Correlations	History	Flexibility
History	Pearson Correlation	1	0.042
	Sig. (2-tailed)		0.453
	N	315	315
Flexibility	Pearson Correlation	0.042	1
	Sig. (2-tailed)	0.453	
	N	315	315

Possible causes are related to several spheres. On the one hand, it is about the ability to work exercises with a higher degree of difficulty, involving a greater teaching effort. On the other hand, it is about the willingness to conceive, plan and implement complex projects and last but not least, there is the interest for mathematics itself. There are educators who admitted they are not skilled at math and thus they avoid doing lessons with a mathematical content that have a high level of difficulty.

The circular diagrams accurately reflect the real situation. On the one hand, only 5.27% of educators said they did not use logical -mathematical game in the current activities, and of these, 3.29% stated that they believed that a game could be adapted to become logical game, 1.32% appreciated that not every game could be adapted to become logical game, 0.33% stated that this depended on the chosen theme, and 0.33% answered that they considered it likely for any game to be converted into logical game, because the two types of games targeting the same type of objective. On the other hand, 94.73% of educators said they had used logical -mathematical game in current activity. Of these, 78.95% said that they believed that a game could be adapted to become logic game, 4.28% appreciated that not every game could be adapted to become logic game, 3.29% stated that it depended on the chosen theme, 0.33% answered they did not know, 5.26% considered that it was possible for any didactical game to be turned into a logical-mathematical game because both games had the same structure and 2.62% appreciated that it was likely to be transformed any teaching game into a logical game, because the two types of games aimed the same type of didactical objectives (Figure 3).

FIGURE 3



The correlation between seniority in education and flexibility to adapt a didactical game to become a logical-mathematical game

2. The fact that a teacher has used until the present logical-mathematical games influences his willingness to apply the logical-mathematical game to a broad variety of target groups.
Once again, the Pearson correlations reveal that if a teacher used the games logical-mathematical in current activities, this does not influence directly major his willingness to apply the logical-mathematical game to a large range of target groups (Table 2).

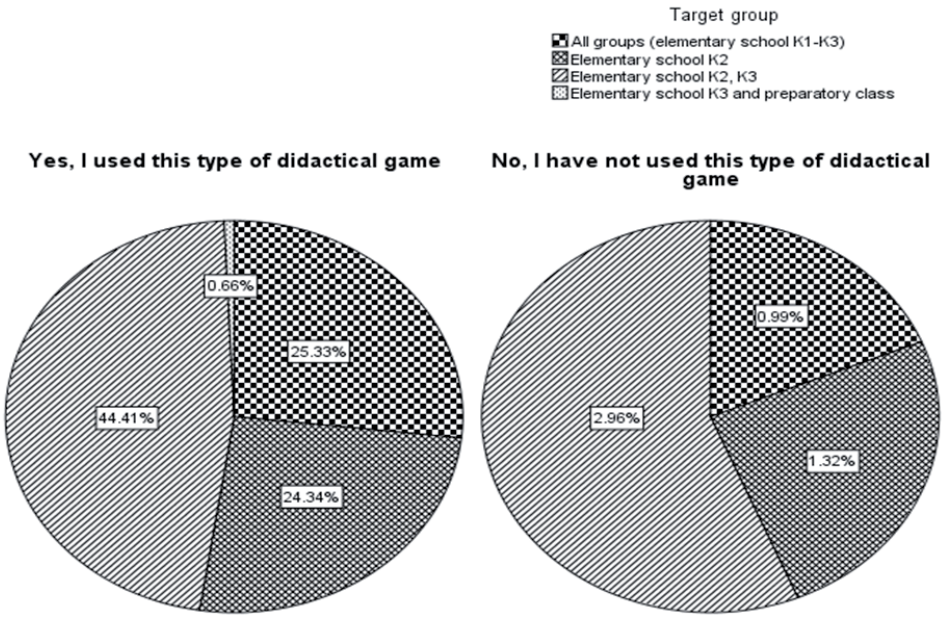
TABLE 2

The correlation between the recurrence of the logical-mathematical games and the availability to apply them to broader range of target groups

	Correlations	History	Target group
History	Pearson Correlation	1	0.051
	Sig. (2-tailed)		0.369
	N	315	315
Target group	Pearson Correlation	0.051	1
	Sig. (2-tailed)	0.369	
	N	315	315

The possible explanations are related, on the one hand, to the type of target groups that the teacher has now (it is possible that the present groups have a lower intellectual level), on the other hand, they are related to the educator's predispositions current stage, who, from objective or subjective reasons, might not be interested in this type of game teaching.

FIGURE 4



The correlation between the recurrence of the logical-mathematical games and the availability to apply them to broader range of target groups

The histograms made depending on the responses of educators, reveal that of those who have not used up to now the logical-mathematical games, 0.98% answered that they thought this kind of game could be applied to all groups (elementary school K1-K2-K3), 1.32% appreciated that this type of game was specific to elementary school K2- K3 groups, and 2.97% felt that this game was specific to elementary school K3 groups. Of those who responded that they routinely applied the logical game, 23.42% felt that this type of game could be applied to all groups (elementary school K1-K2-K3), 24.75% appreciated that this type of game was specific to elementary school K2-K3 groups, 45.87% said that this game was specific to elementary school K3 groups, and 0.68% appreciated that this type of game could be organized to elementary school K3 groups and to preparatory class (Figure 4).

3.The fact that a teacher has used until now logical-mathematical games influences his/her willingness to use sources as varied and as highly professional standards in the design of logic games. The Pearson correlations reveal that a person who has applied logic games in the current activities is less prone to use a greater number of resources in designing an activity of this kind, there is even a negative correlation (-0.069), which suggests that the general trend is that the teachers who have experience in using the logical game rely more on their own experience in preparing the teaching activity than on consulting specialized resources. It shows a significant Pearson correlation between the experience groups in teaching and the tendency to use many resources in designing logical games (Table 3).

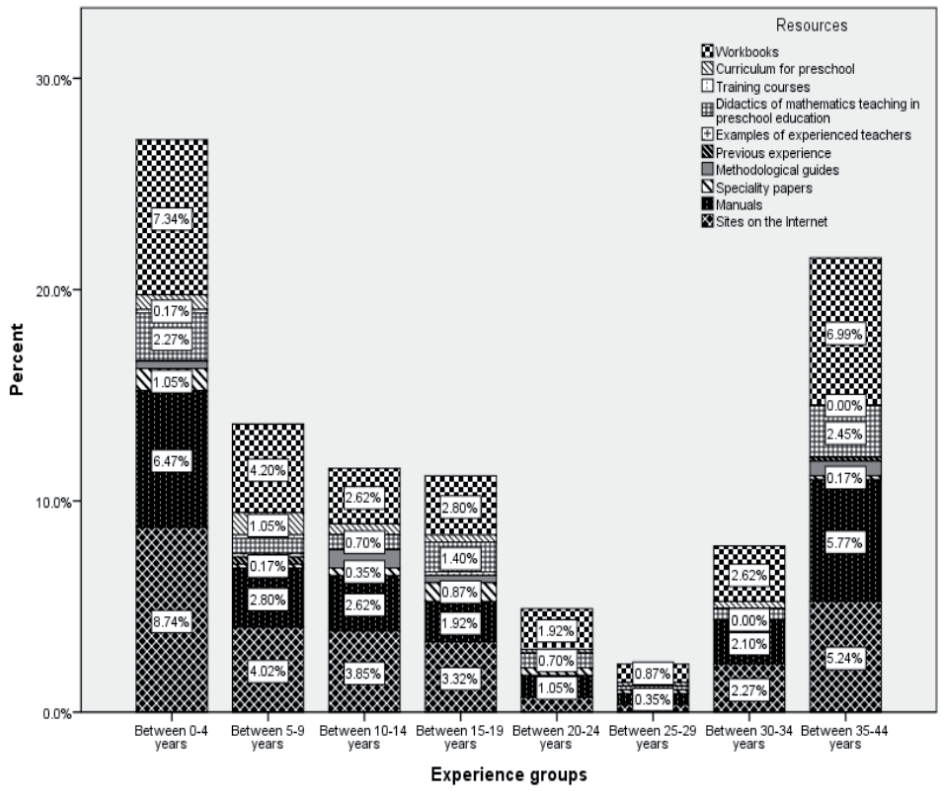
TABLE 3

The correlation between the historic of using the logical-mathematical games, the seniority in education and the number of resources used in designing the logical-mathematical games

Correlations Control Variables		**Historic of using the logical-mathematical games**	**Seniority in education**	**Number of resources used in designing the logical-mathematical games**
Historic of using the logical-mathematical games	Correlation	1.000	0.050	-0.069
	Significance (2-tailed)	0	0.381	0.224
	Df	0	312	312
Seniority in education	Correlation	0.050	1.000	0.021
	Significance (2-tailed)	0.381	0	0.714
	Df	312	0	312
Number of resources used in designing the logical-mathematical games	Correlation	-0.069	0.021	1.000
	Significance (2-tailed)	0.224	0.714	0
	Df	312	312	0

The histograms corresponding to the correlation between experience in teaching and the number of resources used in the preparation of logical-mathematical games reveal that there is a keen interest in documenting in the first period of teaching in education (0-19 years), this concern is inversely proportional to the experience / seniority corresponding to a minimum experience between 25 and 29 years, during which it seems that boundedness syndrome is installed. It was revealed that there follows a step in growing of interest in documentaries, this being confirmed by the large number of respondents in the age category 30-34 years (6.98%) and 35-44 years (16.82%) which indicated a significantly higher number of resources used in designing logical games (Figure 5).

FIGURE 5



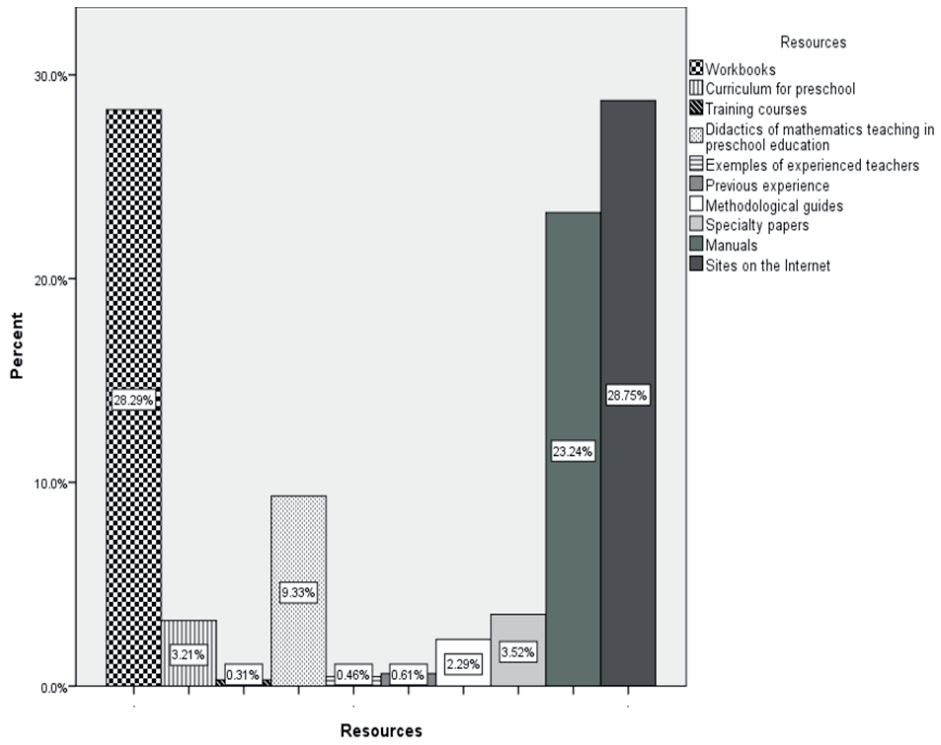
The correlation between seniority and the number of resources used in the preparation of logical-mathematical games

A critical analysis (such as communication theory) of these histograms must be done taking into account that the measure of real information is the area of intersection (hatched) of the subgraph obtained by the representation made with the responses to the questionnaires and the subgraph of the bell Gauss. Therefore, we infer that this so-called growing interest for documentaries in the category of older than 30 years is rather an illusion generated by various causes, objective or subjective, such as the fact that the teaching staff that works with the respondent educators is demanding and professional standards are raised in those kindergartens or respondents in this experience category have complied with the tendency to give a legitimate answer.

From the resources considered attractive and useful in designing logical games, teachers firstly mention some sites on the Internet (28.75%) which seem to have enough concrete examples of such games that can be used in the current activities,

the workbooks (28,29%) represent a second example of top choices made by the kindergarten educators, because these books have the advantage that they contain games designed to be directly used in teaching, textbooks (23.24%) are also useful because they have enough models that can be adapted appropriately to the contents and objectives are concerned in certain activities, and the didactics teaching mathematics in preschool education also have an important share (9.33%) in their preferences because educators have theoretical but also practical useful examples in preparing to plan the logical-mathematical games (Figure 6).

FIGURE 6



The amount of resources used in the preparation of logical-mathematical games

CONCLUSIONS

If we regard the logical-mathematical game in terms of finalities (the comprehension of causal relationships between actions and events, the developing of logical reasoning, and the performing of operations and logical deductions) we understand the importance of

paying greater attention for the development of the logical-mathematical games, from the plan phase to implementation phase, respectively the dissemination phase of the results achieved by children, among parents, at the school level that includes the children, but also in other educational units which collaborate with the educators.

In a study (Li, Chi, DeBey & Baroody, 2015) which involved using a questionnaire to investigate the mathematics teaching practices of U.S. and Chinese early childhood teachers, a quantitative and qualitative analyses yielded several key findings. Firstly, U.S. teachers are less intentional in mathematics teaching than their Chinese counterparts (27% of the U.S. participants versus 24% Chinese participants did not set any goals for mathematics; 20% of the U.S. participants versus 17% Chinese participants did not use a curriculum or any resources). Secondly, early childhood mathematics content in the United States appears to be broader and less differentiated by age groups than in China. Lastly, emerging curriculum (mathematics learning that emerges from children's play, activities, and routines) is the prevailing approach for 3- and 4-year-olds in the U.S., in contrast to the China, where the mathematics-specific teaching is the primary, but not sole form of instruction.

The present study is more restricted as an area of interest and is based on the analysis of the use of existing resources in the design and use of logic-mathematical games on early education in Iași, Romania. After applying the questionnaire in preschools from Iasi, it was found that despite the knowing of the importance of using logic games, they have a lower recurrence in current educational activity.

The hypothesis of a dependence between experience and use of the logical-mathematical game in the current activity proved to be more restrictive, since the analysis of the histograms made based on the questionnaire answers given by teachers from the target group, measured from the perspective of real information, reveals that only the teachers with a reduced experience in education appear more interested in using game logic in daily teaching activity, and, in general, the logical game is not a tool to be used routinely.

The hypothesis that the teacher who used before logical-mathematical games is more flexible in adapting a teaching game to become logical-mathematical game is weak confirmed by the Pearson correlations, the possible causes belonging to the low capacity to guide the solution of the exercises that involve high effort in teaching, limited availability to conceive, design and implement complex projects, and minor interests in teaching mathematics itself.

The hypothesis of availability of the teachers who used before logical-mathematical games in applying this type of game on a larger broader range of target groups is weak confirmed by the Pearson correlations. Possible explanations are related either to the type of target groups that the teacher currently has (who does not favor implementation of logical games), either to the stage of current predispositions of

the educator, who, from objective or subjective reasons, has no interest for this type of didactical game.

The hypothesis of a dependent between the willingness of a teacher who used logical-mathematical games with as varied as possible sources with high professional standards in designing logical games was confirmed. It shows a significant Pearson correlation between experience groups and the tendency to use a lot of resources in designing logical games. Additionally, there is a negative correlation (-0.069) between the historical and the number of resources used, which suggests that the general trend is that the teachers with experience in using logical games rely more on their own experience when preparing teaching activity than on specialized consulting resources. It was also noticed an abundance of resources in planning the activities by the teachers in the early years of seniority like sites on the Internet, the workbooks, manuals, excerpts of games, didactics of teaching mathematics in preschool education. In the group of 5-9 years' experience / seniority in education, the previous experience is also specified as an active resource in designing and implementing logical-mathematical games.

References

Aunola, K., Leskinen, E., Lekkanen, M.-L., & Nurni, J.-E. (2004). Developmental dynamics of the math performance from pre-school to Grade 2. *Journal of Educational Psychology*, *96*, 699-713.

Barbu, H., Popescu E., & Şerban, F. (1993). *Recreative and entertaining game*s. Bucureşti: Didactical and Pedagogical Publisher.

Bocoş, M. (2002). *Interactive learning*. Cluj: University Press.

Carroll, L. (1897). *Symbolic Logic*. London: Macmillan and Co.

Chateau J. (1970). *The child and the game*. Bucureşti: Didactical and Pedagogical Publisher.

Claparède, E. (1946). *Psychologie de l'enfant et pédagogie expérimentale. 1. Le Développement mental*. Neuchâtel, Paris: Delachaux Niestlé.

Clements, D. H., Sarama, J., Spitler, M. E., Lange, A. A., & Wolfe, C. B. (2011). Mathematics learned by young children in an intervention based on learning trajectories: a large- scale cluster randomized trial. *Journal for Research in Mathematics Education*, *42*, 127-166.

De Singly, F., Blanchet, A., Gotman, A., & Kaufmann, J.-C. (1992). *L'Enquête et ses méthode*s. Paris: Éditions Nathan.

Dienes, Z. P., & Golding, W. E. (1970). *Les premiers pas en mathématique. Logique et jeux logique*s. Paris: Éditions O.C.D.L.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., et. al. (2007). School readiness and later achievement. *Developmental Psychology*, *43,* 1428-1446.

Fischbein, E. (1970). *Diary of modern pedagogy*, vol. 1. Bucureşti.

Galperin, P. J., & Kotik, N. R. (1982). To the psychology of creative thinking. *Questions of psychology*, *3*.

Geary, D. C., Hoard, M. K., Nuget, L., & Bailey, D. H. (2013). Adolescents' functional numeracy is predicted by their school entry number system knowledge. *PLoS ONE, 8,* e54651.

Jordan, N. C., Kaplan, D., Ramineni, C., & Locuniak, M. N. (2009). Early math matters: kindergarten number competence and later mathematics outcomes. *Developmental Psychology, 45,* 850-867.

Kagan, S. L., Moore, E., & Bredekamp, S. (Eds) (1995). Reconsidering children's early learning and development: toward common views and vocabulary. *Report of the National Education Goals Panel, Goal 1 Technical Planning Group*. ERIC, ED391576. Washington, DC: U.S. Government Printing Office.

Li, X., Chi, L., DeBey, M., & Baroody, A. (2015). A study of early childhood mathematics teaching in the United States and China. *Early Education and Development*, *26*(3), 450-478.

Petrovici, C. (2014). *Didactics of mathematical activities in preschool*. Iasi: Polirom Publisher.

Schulman-Kolombus, E. (1998). *Preschool Didactics*. Bucureşti: Editura V & Integral.

Seefeldt, C., & Galper, A. (2004). *Mathematics - Study and teaching* (Early childhood) - Activity programs. Upper Saddle River, N.J.: Pearson/Merrill.

Shannon, C. E. (1948). A mathematical theory of communication. *Bell System Technical Journal, 27*, 623-656.

Siegler, R. S., & Ramani, G. B. (2009). Playing linear number board games – but not circular ones – improves low-income preschoolers' numerical understanding. *Journal of Educational Psychology, 101*, 545-560.

Siegler, R. S., Duncan, G. J., Davis-Kean, P. E., Duckworth, K., Claessens, A., Engel, M., et al. (2012). Early predictors of High School mathematics achievement. *Psychological Science, 23*, 691-697.

Thurstone, L. L. (1974). *The measurement of values*. *Chicago: The University of Chicago Press*.

Appendix

Questionnaire

We appreciate your willingness to collaborate with our project team. Please note that you should not sign your questionnaire. Please read the contents of the questionnaire and give honest answers to the questions.

It is known that logical-mathematical games are didactical games that introduce connectors and logical operations into verbal expression while aiming to train skills that develop value judgments, which express logical drives. Looking from this perspective, please tell us:

1. Have you ever used this type of game teaching in your current activity? Please provide details.
2. Do you consider that a didactical mathematical game can be adapted to become a logical-mathematical game? Please provide details.
3. What suggestions do you have for those who have no experience in implementing this type of logical game? Please provide details.
4. Do you believe that this type of didactical game is useful for teaching activities? Motivate by at least 3 reasons.
5. Which preschool groups are best suited for this type of logical game? Please provide details.
6. What do you think should be the frequency in the use of this didactical game? Please provide details.

7. Would you be interested to use this type of game teaching more often? Please provide details.
8. Can you think of any reasons why this type of teaching game is not used more often? Please provide details.
9. What is your experience in education?

Many thanks for your time!