Title: Playing with reasoning: experimental research of the Mind Lab[1] method in primary schools

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Abstract

The Mind Lab method, which includes games and strategies, is a new element within the panorama of innovations in Italy, not because there have not already been initiatives focusing on play, but because unlike those, this is not an extracurricular activity, but rather an integral part of the "morning" curriculum. This work aims to test the acquisition of the abilities promoted by the Mind-Lab method, in terms of cognitive abilities and emotional development, the effectiveness of which needs to be demonstrated. This makes it necessary to consider the contextualisation of abilities, and to take this into account as much as possible when creating tools to measure those abilities.

Keywords: play, life skills, educational experimentation, decision-making strategies, narration

Introduction

The ability to inspire the development of learners' mental abilities in a persistent and lasting manner is an age-old ambition, although it has taken different forms and has had different focuses. Assigning a different value to specific subjects, such as Latin and maths, is based on the conviction that certain types of learning can promote the acquisition of abilities which are more useful on several levels: the theory of formal discipline, which L.S. Vygotsky was already writing about at the beginning of the 1930s, represents one of the formulations of this aspiration.

What is implicit in this topic is that cognitive abilities are highly transferrable, a conviction which forms the basis for the Piagetian studies, to cite just one example, and which has been sharply criticised due to the recognised contextualisation of cognitive abilities; in other words, this means that cognitive abilities are closely linked to the working context, so the ability to generalise and transfer them should be demonstrated on a case by case basis.

This does not take away from the fact that implicit in the idea of education is that some content/abilities are transmitted rather than others because they are considered to be more instructive; education can regard content, for example to promote a feeling of belonging to the

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[1] The Mind Lab Group carries out activities for the development and training of thinking abilities and life skills through strategy games. Mind Lab's curricula are integrated within educational courses, with lessons held once per week throughout the school year, from kindergarten to secondary school. The Mind Lab Group uses games (e.g., Chinese checkers, treasure island) as educational tools with the goal of developing thinking abilities and social and emotional skills (see website: www.mindlabitalia.com).

community in the transmission of historical memory, or it can regard abilities, as in the case of maths, which are deemed useful as life skills.

The necessary re-thinking currently required to make education more effective at promoting cognitive abilities - like knowing how to analyse situations, make decisions, identify the costs and benefits of each based on the relevant limits and advantages, knowing how to work with others - is the foundation of many innovations and experimentation. One of the difficulties that those experiments must overcome is the willingness of teachers to reconsider their own knowledge and put it up for debate in order to apply methods which diverge from usual practices. This is a well-known difficulty which, at the end of the 1970s, gave rise to curricula which were defined, in an almost offensive manner, as "teacher proof", in the sense that however they were applied, they would work. However, those experiments did not have the desired effect, because teachers' lack of recognition of this as a method created much more harm than the experiments attempted to resolve. Today, teachers' active and knowledgeable involvement is still a fundamental aspect in the development of innovations.

The Mind Lab method, which includes games and strategies, is a new element within the panorama of innovations in Italy, not because there have not already been initiatives focusing on play and its educational functions (e.g., chess), but because unlike those, it is not intended to be an extracurricular activity to be conducted outside required school hours, but rather an integral part of the "morning" curriculum. This means that it is based first and foremost on the recognition of the fundamental abilities that Mind Lab aims to promote; these involve play and reasoning strategies. Below, we will refer to the theoretical frames that support the organisation of Mind Lab's activities, and the experimental research conducted.

Play and decision-making strategies

In game theory, the distinction between *play* and *game* is clear: "first of all, it is necessary to distinguish between the abstract concept of a *game* and the individual *plays* of this *game*. The *game* is simply the *totality* of the rules that describe it. Each particular case in which the *game* is *played* in a particular way is, from the beginning to the end, *play*. In the second place, it is necessary to establish a corresponding distinction for the *moves* which make up the *game*. A move is the occasion for a *choice* between several alternatives which must be made by one of the players or through a tool which generates random outcomes, under the exact conditions set out by the rules of the *game*. The move is nothing more than this abstract "occasion", with the descriptive details that follow it, that is to say, a component of the *game*. The specific alternative chosen in a concrete situation, for example in a concrete *play*, is the *choice*. Therefore, moves are correlated with choices in the same way in which the *game* is correlated with *play*. The *game* consists of a sequence of moves and *play* of a sequence of choices" (von Neumann and Morgenstern, 1944, p.129).

Therefore, a *game* is the set of codified rules which describe it, while *play* is the concrete enactment of the rules in a specific game, under the conditions established for it, and *choice* is one of the decisions made between possible alternatives in a concrete situation.

Underlying all of organisational sociology is the "problem of choice", in particular the attempt to define the relationship between objectives, expectations, choices, decisions and actions, which can be theoretically summarised as the passage from Simon's *decision making* beginning in the 1950s to Weick's *sensemaking* in 1995.

Weick tends to establish equivalence between *sensemaking* processes and the mental and social processes of *organizing*. For Weick, making sense and organising are the same thing. From the methodological perspective, this means: thinking in terms of processes instead of results, verbs instead of nouns; recognising that those processes regard people and organisations in the same way; considering that the processes under consideration are highly subjective; considering that

sensemaking acts retrospectively by giving form and meaning to experiences. *Sensemaking* is structured through language; it is articulated into phases which refer to each other in a circular manner (change, enactment, selection, retention) and it assumes some specific properties. It does not coincide with the interpretation; it precedes it because it regards the ways in which people generate that which they then interpret. Although it is a continuous process, there are occasions which generate *sensemaking*, for example a *shock*. A *shock* or a situation of imbalance occurs every time an event (planned or unplanned) interrupts the course of preceding events (actions, plans, thought sequences), or when an unexpected event interrupts an action under way, or when an expected event does not occur. Play situations are generally structured as specific occasions for sensemaking within a system characterised by rules and pre-established expectations and defined objectives.

On the basis of the objectives and abilities that Mind Lab intends to develop, it is possible to theorise that, when placed in play situations and/or "problematic" situations, students who attended the Mind Lab course initiate a process of *sensemaking* and act using criteria and principles similar to those employed by the *reflective professional* (Schon, 1983): that is, first of all seeking to best understand the characteristics of the given situations (reasoning, rules/restrictions, possible alternatives, threats, opportunities/resources), identifying the choices, examining their possible consequences with respect to the defined objective and as a result, constructing a specific decision-making process.

Reflection regards the way in which, in a specific situation, the agent involved in the action observes, makes decisions and acts, activating a "reflective conversation with action". This regards subjective experience (such as sensemaking) and occurs by transforming the subject or the situation into a significant set of actions and relations to be understood through subsequent steps. In that sense, reflection does not separate subjectivity or the social dimension of practices from the situation examined, but to the contrary, it unites cognitive elements with social and emotional aspects.

The set of tools developed to check the abilities developed with Mind Lab were created while taking various types of abilities into consideration: cognitive, social-emotional, linguistic-relational and, especially, seeking to imagine "reflective situations" (such as games, performance and its characters, problematic situations) able to make their situated use by children evident. In this testing approach, sensemaking therefore refers not only to awareness of the game, but also to how one is positioned during play, in problematic situations, as well as an understanding of the synergistic characteristics of the various agents[2]. That awareness requires conversation with the other (human and non-human) as well as with the action/situation. This does not regard only the *individual* and his or her *own* action. In this testing process, based on the enactment of a set of "situated practices", the subject becomes an actor in a system of activities in which other actors, objects and point of views also take part.

The way in which the "reflective situations" are chosen, constructed, invented, described and designed becomes crucial; in other words, this involves promoting situations in which one must explicate reasoning, reconstruct situations and assign meaning.

Narration as sensemaking

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[2] By agents, we mean both actors and their concrete and variable manifestation, and recurrent and abstract types. It is possible to consider human agents, such as children who must make decisions about some situations; fantasy agents, such as the characters in a performance; and non-human agents, such as the pieces to be moved on a game board. This makes it possible to analyse decision-making processes by considering them to be practical situations which take place within a complex field of interaction amongst multiple agents.

Sensemaking which takes place through involvement in Mind Lab's activities is not only related to play situations, but also to analogous and varied problem solving situations.

Here, problem solving is understood broadly since it involves not only finding a solution for a play activity, but it can also be a narrative-type problematic situation. In telling stories, for example, when the child is required to continue and conclude a narrated story, he or she is encouraged to imagine different endings which are consistent with the information available.

In fact, the story is a means of representing reality, not through the events in and of themselves, but through a series of relations suggested by the dynamic sequence of the events. Games also try to represent reality, but while the story presents the facts in an unchanging sequence, games present alternatives and decision-making strategies which allow players to build their own stories, making choices as they do so. Those listening to the story must infer the causal relationships of a single sequence of events; the game player is encouraged to explore alternatives, contrasts and inversions. The game player is free to explore the causal relationships from many different perspectives, and expects to play many times, looking for different strategies each time. To the contrary, the value of a story's information decreases over time if the narration does not present new information.

A story is represented by a series of organised events which suggest a cause/effect relationship between certain events: an initial, negative situation provokes some actions by the hero who carries out the actions to remove that negative situation (Propp, 1966).

In narration, what is important, other than the chronological order of events, is their interaction, the balance or lack of balance between the components (actor, act, purpose, scene and means; Burke 1945), the dialectic between the *two planes*, or *levels*: that of reality or the external world, and that of consciousness or the internal world (*landscape of action/landscape of consciousness*). The task of narrative thought, through narration, is to coordinate these two planes, that of the sequence of events and the qualitatively more complex one represented by the thoughts, sentiments, emotions, intentions of the story's characters and of the narrator (Bruner, 1986) - an internal world that does not necessarily follow the laws of causal and deductive logic. The child is confronted with that task in the course of development, also by virtue of the evolution of cognitive, linguistic and social abilities.

Testing cognitive abilities in the Mind Lab experience

How can we face the problem of testing cognitive and social-relational abilities which refer to the theoretical perspectives outlined above?

In order to verify the cognitive abilities promoted by an educational method, the meaning of the ability itself and its translation into operational terms must first be defined before the measurement process can commence.

As regards the meaning, this refers to a theoretical approach which makes it possible to precisely define the abilities to be measured, and as a result standardised criteria and tools which are consistent with that definition.

In fact, if we want to begin to test a specific ability, such as problem solving, it is necessary to first refer to the psychological-cognitive perspective which has particularly focused on this type of issue, and also identify the type of problems to be used as measurement criteria and the strategies which must be implemented in order to solve those problems.

In reality, it is quite different to resolve scientific/natural, mathematical, social or historical problems; even remaining within the cognitive framework: for the first two types, it is possible to identify algorithms which are related to so-called "well-structured" problems, while in the other two

types, the problems are "not well-structured" and therefore first need to be redefined in order to access the specific, pre-chosen problem solving strategies[3].

This essential difference between mathematical and scientific/natural problems on the one hand, and social and historical problems on the other, has resulted in two different problem solving processes. In fact, the first are actual solving processes because a shared solution which is recognised as such by experts is reached, while in the case of social and historical problems, the solving process is in fact a process of argumentation which entails justifying the new representation proposed by the person who "resolves" the problem.

The considerations made until this point illustrate an approach which highlights the partial universality of cognitive abilities, since they are linked to context and, in any case, their promotion in an educational setting must take into consideration the effect caused by operating conditions: in terms of content proposed, in terms of the contexts in which acquisition takes place, in terms of relational processes and the climate in which performance is requested. The implications of the premises summarised here are set out below. The first refers to the basic assumption that is it is absolutely difficult to support the universality of cognitive abilities, both due to the cultural element, which by now has been demonstrated by long-term psychological research, and due to the content component. This does not mean that there are no abilities which can be used in a wider range of areas, and therefore which can be more useful for people who acquire them, but it means that the extent of validity of those acquisitions must be recognised, especially their possibility to give rise to mentalities open to assuming particular attitudes of engagement (full involvement) in cognitive challenges. In the second place, it is necessary to develop testing which is analogous to the tasks and performance required in Mind-Lab games; otherwise, we run the risk of checking abilities that many have been promoted and acquired in other contexts and with other activities.

Instead, to verify how much the habit of facing problems of the type proposed by Mind Lab positively contributes to the search for adequate resolution strategies for more general problems, it is appropriate to construct progressive tests, so, tests which make it possible, once the acquisition of abilities more directly related to Mind Lab's activities is ascertained, to begin checking the acquisition of abilities which could represent a consequential increase of the Mind Lab abilities.

All of these positive aspects require experimental research; experimental testing must maintain a strong link with the abilities practiced in Mind Lab; what is under discussion is the reliability of the testing tools used: the abilities to be checked must be precisely those required by the test. It is also necessary for these tools to be, so to speak, homogeneous with respect to the activities carried out, and to have as many features of the activities as possible.

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[3] In this type of study, the by now classic research of James Voss et al. is an important reference. At the end of the 1980s, they provided a considerable impetus for focusing on the specific features of reasoning within historical and social frameworks (cf Voss et al. 1983a, 1983b, 1986, 1988, 1989)

The tests characteristics must therefore include: a) a link with the reality lived by the children at school; b) a procedure comparable to those practiced in school; c) an increase in difficulty in relation to the students' ages; d) a progressive expansion of the relevant context.

There is nothing similar in tests available on the market[4], because the tools, mainly verbal, which measure metacognitive abilities are not suited to this purpose; furthermore, tools which measure emotional dimensions are essentially diagnostic-clinical in nature and therefore they are not suited to MindLab's testing purposes either.

The construction of tools begins with an analysis of the games and strategies used by Mind Lab and relating to those abilities; in other words, the test must be reliable, that is, it must measure precisely the ability that is identified. This makes it necessary to consider the contextualisation of the abilities and to take this into account as much as possible when building tools to measure them.

Furthermore, the test must be broken down into the two areas distinguished by Mind Lab: games and strategies; as regards games, it must reference materials/designs that entail the same play situations as those tested and, at the same time, which require the activation of the abilities promoted by Mind-Lab; in the case of strategies, since they are more specifically metacognitive in nature, additional levels are distinguished, so the cognitive, emotional and social levels; the experimental test is broken down and set up based on the age of the children being tested.

Test design: performance vs. decision making

The testing of abilities developed through Mind Lab poses the problem of choosing how to articulate the experimental design with respect to what is being tested. Speaking in terms of extremes, it is possible to identify two main alternatives:
- testing based on the *centrality of performance*
- testing based on the *centrality of the decision-making process*.

Those alternatives correspond with two different conceptual testing models, which in turn correspond with different subjects, hypotheses and testing procedures.

In the first case, what is being tested is directly related to the effects of Mind Lab on the *performance* recorded in other subject areas, such as maths and Italian. In this case, the experimental design is created with the goal of testing if students who attended a Mind Lab course have significantly different marks in the subjects mentioned, compared to students who did not attend Mind Lab, net of the learning set out in the academic curriculum in the intervening time. In fact, in this case we find ourselves with a double hypothesis: (1) there is a relationship between marks in the subjects indicated (e.g., maths and Italian) and participation in Mind Lab, (2) that correlation makes the performance in those subjects of students who attended Mind Lab significantly different from that of the group of students who "only" attended traditional lessons, which would therefore be a solely curriculum-based increase. The value and/or evidence of the contribution of Mind Lab would therefore be demonstrated in this case mainly through the transfer of the abilities learned there to other subjects.

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[4] In fact, cognitive tests are meant to measure cognitive abilities from the perspective of typical and atypical development (e.g., WISC-R, Raven's Matrices), while those which require the completion of stories or the interpretation of images, vignettes and/or situations are of a predominantly projective nature, for the diagnosis of personality disorders (e.g., TAT, CAT, Blacky Pictures)

The study of materials relative to learning *units*, on which Mind Lab is based, separated into *lessons* with a recurrent internal structure, as well as the comparative study of the characteristics of the games, methods, learning strategies, stated objectives and abilities, leads to another hypothesis: that based on the centrality of the *decision-making process*. In this case, the experiment is designed with the goal of observing whether students who attended Mind Lab decide what to do in specific situations, in a manner different from students who did not attend Mind Lab[5]. In this case, the experimental design must be able to test the set of hypotheses: (1) the choices made in specific testing situations by students who attended Mind Lab are significantly different, on average, from the choices made in the same situations by students who did not attend Mind Lab; (2) that difference, if it exists, demonstrates the Mind Lab group's greater attention to the reflective, social and strategic dimensions of decision-making processes.

From the theoretical point of view, in the first case the problem is of performance, while in the second the problem regards choices and the development of the decision-making process. The centrality of play in learning with Mind Lab makes both areas open to investigation; however, they involve experimental situations based on very different hypotheses and tests.

An analysis of the relation between the specific features of the games, methods, learning and game-playing strategies, and Mind Lab's stated goals, favoured the second route.

The test design therefore involved creating *two independent groups*: one group of students who attended a Mind Lab course (test group) and one group of students who did not attend a Mind Lab course (control group), for each of the classes being tested (second and fourth grade of elementary school)[6].

Given the characteristics of the tests, the comparison between the results of the test group and those of the control group is a comparison between means calculated on independent groups. The null hypothesis is that the two means are equal, while the alternative hypothesis can be bidirectional (the means are significantly different from each other), or monodirectional (one mean is greater or greater than or equal to, or less or less than or equal to the other). A monodirectional alternative hypothesis makes it possible to make the hypothesis and the test design more stringent. This entails

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[5] For example by analysing the aspects of the situations, identifying threats and opportunities, verifying possible alternatives within a system of rules, choosing that deemed most appropriate on the basis of the analysis conducted and the objectives to be reached.

[6] The abilities developed by second- and fourth-grade elementary school students after participating in a Mind Lab course were tested in the provinces of Trento and Vicenza. This made it necessary to develop two files of different tests, suited to take into account the different academic career of the students and their educational experiences in Mind Lab. The students were selected by using a multi-stage sampling system which took into consideration some variables such as: geographic area (centre, suburbs); type of school (e.g., public/private, number of classes, number of students, organisational complexity, M/F, etc.); class characteristics (Mind Lab, M/F, marks, absences, etc.). Some conditions were satisfied in order to declare the two samples independent. There were 133 second- and 163 fourth-grade students involved in the testing activity. They were selected through a sampling process which entailed first the selection of the schools, then of the complexes, and finally of the classes. Overall, the sample is well structured in terms of some structural variables: by province (Trento and Vicenza), by ML and NOML experiment, by gender, by evaluation provided by teachers (high, middle, low). Furthermore, there was good consistency in terms of numbers, at least 30 units per individual school. This makes it possible to better control effects of structural variables on test results, thereby reducing distortions.

a precise structuring of the response alternatives, which must be set up so as to relate to a specific latent dimension and organised in an incremental fashion in the same direction.

The testing tools

The tests were created by setting up "game-playing" and/or "problematic" situations, in relation to which students are asked to make choices understood as "crucial" with respect to the development of the situation. The students are then put into testing situations, based on the resolution of games or problematic situations, which require them to make a choice between two possible alternatives. In this manner, they are prepared to anticipate the *future* in play and the consequences of choices in the given situation, on two levels: through the practical enactment of the rules of the games, and by applying specific methods and strategies to identify the solution deemed most appropriate. Both of these levels are rich with social-emotional aspects related to the possible choices and their consequences.

The tests contained in each file are set up based on the plan below:

- insert plan no. 1 -

The students, placed in the situations described in the tests, can choose to enact different strategies which are defined on the basis of prompts included in the tests which, in turn, do not affect everyone in the same manner, but are visible/obvious (opposed to that which "does not say anything") mainly for agents who possess specific abilities (possibly developed through Mind Lab). The idea is that there is a way of thinking underlying a specific way of making choices and that, therefore, it is possible to identify some logic, some rules, underlying those practices, even though the search for such forms is always tested by the originality of the circumstances. It should be considered that, in this case, together with the students' choices, the practical enactment of the patterns of *habitus* is also demonstrated, that is: inherent in the recording of a specific result is the recording of the so-called non-probabilistic dimensions of the test, which however allow the student, on the basis of the social and cultural capital of his or her family, to anticipate solutions to problematic situations, already pre-classified as positive or negative, frustrating or satisfying, and so forth.

The goal of the tests is to create practical situations in which students' capacity to foresee, to develop possible solutions, of different kinds, can be enacted, stimulated, thereby making possible, bringing into existence, some choices understood as opportunities to be taken advantage of and, at the same time, revealing some specific elements of the strategies which would otherwise remain tacit, incorporated. The hypothesis is that it is possible to identify actual decision-making *strategies* by setting up specific systems of alternatives for each test. It should be considered that behind strategy development lies the possibility of making an evaluation of the relations of power in which a subject (real or symbolic) is immersed in a specific context. This assumes the definition of a specific context and a subject's capacity/awareness in managing relations with a separate exteriority. This is partially made possible by creating games and problematic situations.

The type I tests concentrate on the game-playing situation and make it possible to check learning and the use of rules within a given space (that of the game), to reach the given objective.

Type II tests concentrate on the problematic situation and make it possible to check understanding of the elements of the individual situation and the choice of specific methods/strategies to find a solution to the problem posed.

While type I tests assume the existence of only one correct answer (which corresponds to the solution of the game)[7], type II tests assume the existence of alternatives which relate to different ways of seeking a solution to the problem, amongst which only one corresponds to the Mind Lab methods/strategies, although this does not mean that the others are not "correct" for some reason.

The tests were run in several pilots, which entailed developing a tool-kit including: the file of tests bound into a book with a graphic format suited to the tools; an observation grid[8]; interview outline for the class teacher; an outline of key points for the final in-class discussion with the children. The following figures were involved: a researcher and an observer.

The results regard the learning of 133 children in the second grade and 163 in the fourth grade of elementary school based on 7 tests they took, 2 game-playing situations and 5 problematic situations. As can be seen, there is a rather large corpus of data; due to space constraints, here we will discuss the results of the second grade elementary school students from the overall sample (Trento and Vicenza), in relation to two specific tests.

Experiment results

a) Test characteristics

Problematic situation: "the trip"

In this story, an unforeseen event occurs which makes it difficult to accomplish a planned activity. The minibus that arrives for the trip is smaller than expected, and it cannot hold all of the children from the two classes involved. The proposed alternatives from amongst which the students can choose are: the abandonment of the planned activity; an immediate/impulsive solution that does not satisfy everyone; a creative/opportunistic solution; a reflective solution based on finding out the reasons why the unforeseen event occurred, which includes attempts to negotiate with other actors. All of the alternatives are plausible, but they make it possible to reveal the use of methods and strategies - for example: the traffic light and the detective - which may have been acquired precisely as a result of having participated in the Mind Lab activity.

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[7] It should be specified that the incorrect alternatives were set up so as to enable an analysis of the type of error made (e.g., not reaching the objective, not understanding the rules, improper use of the game space, etc.).

[8] The observation criteria may regard: *Requests for clarification; Requests for an actual explanation; Lack of understanding of some words in the texts; Request for help from a classmate; Tiredness; Boredom; Enjoyment; Delivery time.*

Problematic situation: "the missing book"

In this story, a student realises that he or she does not have the textbook needed to accompany the lesson under way. The proposed alternatives are: giving up looking for the book; the immediate/impulsive solution which involves looking for the book and ignoring the lesson; the creative/opportunistic solution based on sharing resources with other students; the reflective solution involving taking charge of the problem, based on an attempt to understand what happened, with the help of significant others, beginning from the last time the book in question was used. The alternatives are all equally plausible in this case as well, but they make it possible to reveal, as in the last resolution strategy proposed, the use of methods and strategies - e.g.: the detective and the traffic light - acquired through participation in the Mind Lab activity.

Each of the tests described above involved a dual commitment for the children: making a choice from amongst the proposed alternatives and, at a later time, writing an explanation of the reasons for the choices made. This made it possible to conduct a dual analysis on the results collected.

b) The results

"The trip"

Out of 133 children, approximately 55% chose a reflective solution and took charge of the problem. That percentage is a good deal higher, 67.8%, for the Mind Lab test group, while it decreases to 42.6% for the control group. More than the others, students who participated in the Mind Lab experience chose a reflective action strategy, based on attempting to understand the reasons for the problem and seeking out possible solutions together with others, through negotiation.
15.8% of the children chose the strategy of giving up. That percentage was 22.1% for the control group, but only 9.2% for the Mind Lab test group. That choice corresponds to immediate and passive acceptance of a problem, and the abandonment of the search for a possible solution.
15% of the children chose an immediate, impulsive and non-inclusive solution, and proposed that an entire class should not go on the trip. That percentage is 22.1% for the control group, and decreases to 7.7% for the Mind Lab test group.
Finally, 12% of the children chose a creative/opportunistic solution to the problem, which in this case indicates an expansion of the field of action and the identification of additional resources that can be used to reach the objective. That percentage is 10.3% for the control group, and increases to 13.8% for the Mind Lab test group.
Also of note is the percentage of non-responses in the control group (2.9%) compared to the test group (1.5%) and the group as a whole (2.3%).

"The missing book"

Out of 133 children, approximately 26.3% chose a reflective solution and took charge of the problem. That percentage rises to 35.4% for the Mind Lab test group, and decreases to 17.6% for the control group. That choice is related to reflective action based on asking questions of significant others/witnesses in order to reconstruct the factors which caused the problem to occur, so it can then be resolved.

35.3% of the children chose a creative/opportunistic solution to the problem, which in this case implies the enactment of a mimetic strategy in the classroom, useful to reach a slightly modified objective: remaining in class without being caught not following along due to the absence of the book. That percentage comes out to 38.2% for the control group, and decreases to 32.3% for the Mind Lab test group. That choice was the most recurrent in the group.

31.6% of the children chose an immediate, impulsive and individual solution. That percentage is 33.8% for the Lab control group, and decreases to 29.2% for the Mind Lab test group. Finally, 3% of the children chose to immediately and passively accept the problem, and abandon the search for a possible solution. That percentage is 2.9% for the control group and 3.1% for the Mind Lab test group.

Also of note is the percentage of non-responses in the control group (7.4%) compared to the test group (0) and the group as a whole (3.8%).

The main differences in the way of choosing between the test group and the control group can be seen in the results obtained by *testing the difference between the means*[9].

In general, with a probability of error of 5%, it can be affirmed that the differences between the mean scores calculated for each of the tests mentioned result from whether the students had taken a Mind Lab[10] course.

Additional analyses were conducted which took other variables into account and in certain cases, they made it possible to specify the characteristics of the results obtained for the test group and for the control group.

There are some differences between the group of children in Trento and the group of children in Vicenza. It is possible to hypothesise that other variables also impact the effectiveness of Mind Lab, such as the role of the teachers, the didactic methods used and how long the students had attended the Mind Lab course.

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[9] A statistical test is a procedure which, based on sample data, and with a certain level of probability established *a priori*, makes it possible to decide whether it is reasonable to reject hypothesis Ho (defined as the "null hypothesis") and implicitly accept H1 (the alternative hypothesis). The choice between the two hypotheses (Ho and H1) is based on the probability of obtaining, due to chance, the value observed in the sample in the situation in which the null hypothesis Ho is true. The lower that probability, indicated with α and established *a priori*, the more stringent the test type. In this case, we would like to reject the hypothesis that the distribution of mean scores obtained from the tests in the ML group and in the NO ML group is equal () to analyse the alternative hypothesis () or (). Since the standard deviation in the reference population is not known, the student's t-test for independent samples is used.

[10] The student's t-test shows a significant difference between the mean scores obtained from the test: "the trip" of the Mind Lab test group (mean 3.37, standard deviation 1.069) and of the control group (mean 2.68, standard deviation 1.309), t(131)=3.334, p=0.001, α=0.05; and in the "missing book" test between the Mind Lab test group (mean 3.00, standard deviation 0.884) and the control group (mean 2.56, standard deviation 1.056), t(131)=2.617, p=0.01, α=0.05.

The "gender" variable does not play a significant role in distinguishing amongst the results. With genders being equal, within the male/female groups, having participated in the Mind Lab course makes the difference between the results obtained in the tests significant.

The "academic profile" variable does not play a significant role in distinguishing amongst the results. With high, medium and low performance[11] being equal, having participated in the Mind Lab course makes the difference between the results obtained in the tests significant.

The reasons for the choices: an analysis of the words used by students to describe their choices through TALTAC software.

The corpus of responses written by the second grade students includes 603 written forms (different words), which came out to a total of 2887 occurrences (frequencies).

In the second grade, amongst the test group students, 406 different words were used to describe the choices made, out of 1534 occurrences (26%), while for the control group students, 374 different words were used, out of 1353 occurrences (27%).

The ratio between different words and occurrences provides information on the lexical variety of the overall corpus and of the subgroups considered. That variety is synonymous with, on one hand, lexical richness when providing reasons for choices (the number of different words compared to the total number of words used) and on the other hand, it is also an index of the lexical variety of the text (how many total words were spent, used, written) at the basis of which it is possible to identify a certain stability of the phenomena being analysed. It is possible to see that the test group students used a greater number of different words to describe the reasons for their choices, an index of greater lexical richness, and at the same time, they used a higher number of words overall, an index of greater articulation and lexical variety.

An initial analysis was conducted on the most frequent words in the corpus after the (non-radical) exclusion of function words, called "empty words", of little interest[12].

Some written forms directly refer to specific objects of some problematic situations (*trip, book, teacher, minibus*), while others provide evidence of the way in which the children articulated the reasons for their choices, by writing them down. In fact, we find in the top positions: *"because"* and *"so"*, which demonstrate the particular intentions of the writer and, in particular, expose two different logics: the first responds to the need to provide an explanation for an individual choice, and the second regards the need to describe how, and in what manner, one reaches a possible solution to a problematic situation. In the first case, the children seem to provide a personal justification for the choice made, largely based on value judgements with respect to the specific characteristics of the situation. In the second case, the students tend to tell the reasons for their choice and highlight the characteristics of the problematic situations and their possible solutions.

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[11] The teachers of the classes involved in the research experiment were asked to place each student on a scale of three levels: high - excellent/good; middle - fair; low - sufficient.

[12] Empty words are those words which in and of themselves do not express content of interest, and which are not considered in the analysis. In general, these are function words (articles, prepositions, conjugations, some adjectives). However, those words can be very useful to interpret discourse; therefore, their exclusion from the analysis should be considered in moderation and on a case by case basis.

While nouns, considered to be the "objects" or "subjects" of the statement, indicating the arguments on which the text is structured, help us to understand the key components through which choices are articulated, verbs help us to understand the intentions expressed through what the children wrote[13]. Some of the verbs most used by the second grade children were: can, have, be, play, do. Therefore, there were stative, factive, reflexive/declarative and auxiliary verbs.

The words used most frequently were the *stative* verbs be and have, in second place and in the first 10 positions we have *auxiliary* verbs (can, have to, want to), in the fourth place and afterwards we find *factive* verbs (play, go, feel, do/make, be, find, lose, say, fight), and then we have verbs classified as *declarative-reflexive* (like, understand, explain, manage to, help, seem). There are differences between the groups (test and control) in terms of the verbs the children used. The test group children tend to mainly use auxiliary and declarative-reflexive verbs, while those belonging to the control group tend to mainly use stative and factive verbs.

In order to understand the specific differences between the groups (test and control) with respect to the reasons expressed, the distribution of the most significant specific words[14] of the two groups was analysed. By comparing specific words, we can observe that the two groups used different methods to approach the problematic situations: the control group students create an explanation that tends to justify the individual choice based on the specific characteristics of the problematic situations, while the reasoning of the test group children tends to focus on how the problematic situation could be resolved by implementing the option chosen. Within this framework, the test group children refer to specific objects/actors which characterise the problematic situations (*children*, *trip*, *book*, *classes*, e.g.: *"so the classes could go", "so the book is found"*), and to the way they reasoned (*so*, *which*, *at least*, *both*, *probable*, *"at least there is more probability of finding"*, *"so everyone can go on the trip"*), while the control group children focus mostly on the choice made (*"I decided to make this choice because"*) and on the development of an opinion on the choice (*"because it is fair"*, *"because it seems to be the right one"*, *"because it is more convenient"*). As regards intentions, expressed through verbs, the test group uses more auxiliary and declarative/reflexive verbs (*"so maybe I can understand where I put the book"*, *"so maybe I will*

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[13] For this purpose, it can be useful to classify verbs, separating them into *factive*, so referring to an action or doing, *stative*, relative to being and having, and indicating the "state of things", *reflexive* or *declarative*, relative to the area of saying and thinking, *performative*, which make explicit the illocutionary force specific to an illocutionary act, referring to the possibility already noted by Austin (1962) of changing state through a locutionary act, and *auxiliary*, have to, can, want to, referring to obligation, possibility, desire. According to Ghiglione, the use of one of these verb classes is indicative of precise discursive strategies: for example, factive verbs are usually used mainly in political discourse by speakers to "make us understand that they are men who act effectively" (Ghiglione et al, 1998; p. 66, Ghiglione et al 1991); predominant use of stative verbs instead indicates "the speaker's intention to anchor what is said in reality, in order to highlight the truth of the discursive objects utilised" (ibid, p. 66), while the use of reflexive verbs enables the speaker to "place himself into the scene, to take more or less responsibility for what he says, expressing certainty or to the contrary doubt, a more or less proved belief about something or someone" (ibid, p. 66). In addition, auxiliary verbs leave traces of the particular conditions of formulation and existence of the speakers' discourses.

[14] An analysis of the specific forms sets up a comparison between the words used by two or more speakers, with the aim of identifying which words are more or less present in a speaker's discourse than what we would expect with respect to the discourse of another speaker, if all speakers used their language drawing on the same vocabulary and the same topics. The specific lexical analysis is conducted after calculating the sub-occurrences of the different divisions of the corpus (speaker types). The difference in the frequency of the words used by different speakers, in relation to the total words used in the corpus, is demonstrated by applying a statistical significance test based on the hypergeometric law, which makes it possible to define the threshold of probability below which the forms considered are specific.

find the book", "*so if another minibus arrives, all of the children can go on the trip*", "*so we can understand why they sent only one minibus*"), while the control group uses more stative and factive verbs ("*because it is fair to do it this way*", "*because I am sure that the book is in the locker*", "*because if the minibus is full, not everyone can fit inside*", "*because one class goes on the trip*").

Conclusions

As was noted in the introduction, there is a very active need in schools to provide students with abilities that are not directly related to a subject area, but which are equally important; these abilities, some of which are defined as *life skills* according to the European phraseology, have to do with metacognitive aspects, which relate to a dimension of reflection and emotional-relational aspects. The Mind Lab method makes it possible to pursue the acquisition of that set of abilities through activities which are predominantly recreational in nature, with actual games and narrations. From the point of view of the experimental situations proposed for the test, various cognitive processes analogous to those used in Mind Lab activities must be activated. More specifically, in the two problematic situations discussed here, the students had to choose a problem solving strategy which requires taking charge of the problem and therefore:

- understanding the details and characteristics of the situations
- identifying the opportunities for support offered by other subjects/objects in the situation
- organising available resources to reach a goal
- identifying the various opportunities for action, aimed at reaching an intermediate and final goal
- foreseeing the possible consequences associated with a decision
- using the most appropriate methods and strategies to understand and face the situation
- acting reflectively, taking charge of the problem in its many facets and overall dynamics.

Acting by taking charge of the problem in the version of the "***trip***" situation prepared for the second grade suggests a reflective action with respect to an emerging problem, the attempt to understand the reasons why only one minibus arrived (the conditions which caused the problem) and the examination of the possibility that the company could send another (the solution to the problem).

Acting by taking charge of the problem in the version of the "***book***" situation prepared for the second grade suggests a reflective action with respect to an emerging problem and the attempt to reconstruct the emergence of the conditions which caused the problem by asking questions of significant others/witnesses, in order to solve it.

In general, within those problematic situations, the Mind Lab group tends to adopt problem solving strategies which privilege taking charge of the problem and searching for the origin and solution of the emerging problem, while the NO Mind Lab group tends to implement strategies which privilege abandonment or an impulsive and immediate (often partial) solution.

The words used by students to describe the reasons for their choices

By comparing the words used, we can observe that the two groups chose different methods to approach problematic situations: the NO ML students try to give an explanation which justifies the individual choice (the response option chosen), while the ML group constructs arguments which tend to tell how the problematic situation could be resolved with the chosen option. In that framework, the ML children refer to specific objects/actors which characterise the problematic situations ("so the classes could go"), while the NO ML group focuses more on the choice made ("I decided to make this choice because") and on the development of an opinion on the choice ("because it is right", "because it seems to be the right one").

Furthermore, the Mind children explicitly and implicitly consider the "time" variable in their reasoning, (examples: "Because I thought and reasoned a lot"; "Because two classes did not fit on the bus, so they can wait until another arrives"; "Because if she calls them the teacher can send one class first and one later"; "So you remember everything and maybe then you will find it"; "So if she remembers the steps well, then she will find it and she will not have to do the lesson again by herself"; "If she stops for a moment to think, she will surely remember where she put it the last time"), which results in higher complexity in their explanations than that shown by the No Mind children, whose reasoning is very direct and immediate (examples: "Because it is necessary to decide, without wasting time, which of the two classes will go on the trip", "Because it is the simplest", "Because not everyone fit", "So she will find it immediately", "Because those who look, find", "So we can resolve the problem more quickly").

As regards intentions, expressed through verbs, the ML group uses more auxiliary and declarative/reflexive verbs ("so maybe I'll understand where I put the book and maybe I will find it", "so if another bus arrives all of the children can go on the trip"), while the NO ML children use stative and factive verbs more often ("because I am sure that the book is in the locker", "because if the bus is full not everyone can fit inside", "because it was more interesting").

In conclusion, we would like to highlight two aspects relating to the tools developed for the test and the abilities inspired by MindLab activities.

In terms of the tools, the results brought to light their reliability to measure the abilities for which they were created; furthermore, the possibility to obtain statistically significant results which are differentiated on the basis of whether the children participated in the Mind-Lab project demonstrates the accuracy of the measurement and the sensitivity of the tools employed. In that sense, even those results which are not statistically significant are of considerable interest, since they still highlight the different ways in which MindLab children process information compared to the NoMind Lab children; in fact, even in their "errors", the first show manners of positioning themselves with respect to problems which begin first of all from their overall assumption of responsibility. Related to this are reflections on the type of abilities inspired by participation in the MindLab project. The possibility to investigate the performance of little boys and girls with tools homogeneous to those abilities, reveals their greater reflexivity and control of impulses, demonstrated by more thought-out solutions and taking charge of problems, even when the correct solution is not chosen, with a more complex articulation of information; furthermore, the justifications provided are based on reasoning which is not only intended to account for one's choice, but also to present the more general reasons for the solution chosen. Finally, the much lower number of non-responses in the MindLab children's tests compared to the NoMindLab tests also points in that direction: becoming directly involved in the search for a solution and not giving up implies an active and positive manner of processing information, even when the best solution is not found.

Finally, this appears to be an area for future exploration since, because this is an initial experiment, though conducted with caution and methodological awareness, the results require additional experimental confirmations with broader samples and controlled variable characteristics.

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Plan no. 1 – insert on page 8

Test type Characteristics	Test type I	Test type II
Procedures	Test based on the practical enactment of rules of games	Test based on the application of decision-making methods strategies meant to resolve a problematic situation
Second grade	2 new game situations (MindLab reference: games *Quarto* and *Chinese checkers*)	5 problematic situations (MindLab reference: *traffic light method, detective method, migrating birds method*)
Fourth grade	2 new game situations (MindLab reference: games *Rush hour* and *Treasure island*)	5 problematic situations (MindLab reference: *traffic light method, detective method, migrating birds method*)
Test structure	Short narrative Game situation configured through appropriate graphic strategies which are close to the game graphics Description of the game's objective and rules Asking the question Articulation of various response alternatives (existence of only one optimal response and non-optimal responses which correspond with various ways of interpreting the rules and objectives of the game)	Narrative which describes the problematic situation Asking the question which stimulates the identification of a solution Articulation of various response alternatives (existence of one alternative which is closer than the others to Mind Lab's specific methods/strategies)