



# Playing with science

GINZBURG, CATERINA ([caterina.ginzburg@xkezerotredici.it](mailto:caterina.ginzburg@xkezerotredici.it)) Xké?ZeroTredici s.c.r.l.  
ANDREON, CONSUELO ([consuelo.andreon@xkezerotredici.it](mailto:consuelo.andreon@xkezerotredici.it)) Xké?ZeroTredici s.c.r.l.

## KEY FINDINGS

- **Play as a medium can be effective in a group**
- **Cooperate and compete can walk together**
- **Teachers (and educators) are crucial in this process, but autonomy of kids is the real goal**

## SELF-EFFICACY AFFECTS PERFORMANCE

Self-efficacy, better known as perceived self-efficacy by citing exactly the words used by Albert Bandura, corresponds to the awareness of being able to dominate specific activities, situations or aspects of one's psychological or social functioning. In other words, it is our perception of ourselves that we know that we are able to do, feel, express, be or become something.

From these beliefs come evaluations that lead to the development of goals or objectives. Therefore, the goals we wish to achieve derive from knowing exactly what we are able to do and by what means.

Research suggests that self-efficacy works as a hierarchical organization of beliefs with different levels of concreteness and complexity of the action to be performed; these beliefs profoundly

## XKÉ? IL LABORATORIO DELLA CURIOSITA'

- Xké? il Laboratorio della curiosità è a centre for schools (students' age 6 to 13) offering labs in science: teachers can choose among 27 different activities to have their classes live a hands-on experience in STEAM
- The main goal of the Centre is to approach science through creativity, curiosity and a playful experience.
- Open in 2011 for school classes (6 to 13) Xké? is a project focused especially on the idea of an innovative teaching method and to close the gap between kids and science.
- Organized in exhibits and based on the "hands on" method, kids are involved in group activities, games and positive competitions: they can learn by doing.
- Visiting Xké? is not like going to see an exhibition or a traditional museum. It requires interaction, it stimulates kids' curiosity with the overall goal of presenting them with a dynamic, unique learning experience.  
In 2018, over 1000 school groups @ Xké?, 20.000 kids (6/13), 5000 children over the summer.

influence learning and also long-term development (Bandura, 2000a, Ehremberg, Cox and Koopman, 1991). The relationship between self-efficacy and performance is evident in the scholastic context, specifically in defining and organizing the student's learning methods and maintaining an adequate level of motivation in carrying out the proposed activities in the process of building up self-efficacy (Tsang, Hui and Law, 2012).

According to a study a few years ago, children with weakness experience have a low sense of self-efficacy about their academic and social skills, accordingly with previous literature (Bursuck, 1989; Grolnick & Ryan, 1990). Moreover, the study highlights that children with learning disorders even in primary school (or in any case in a state of fragility, not necessarily cognitive, but also social, economic, etc.) begin to develop a negative image of themselves (Ayres & Cooley, 1990; Clever, Bear, and Juvonen, 1992; La Greca & Stone, 1990). The low sense of self-efficacy and the negative self-evaluation contribute in the end to increase levels of social anxiety in children (Cowden, 2009). In this regard, it may be useful to structure educational activities on a cooperative basis and promote teaching practices, so that the most disadvantaged, improve and refine the mastery of the subject, their communication skills and their own self-efficacy.

Taking into account these theories, Xkè? and schools have developed together a specific hands on method on science, that reflects in this specific project. Xkè? had the chance to offer to 11 pilot classes – after the visit to the Centre – a play game with questions, activities and experiences whose aim was to raise the students' self-efficacy by playing together, acting in cooperative teams while competing. The questionnaire filled out by teachers at the end of the activities showed that the board game played in class was successful: students participated actively and as a consequence they were more involved into STEAM than before, raising their self-efficacy.

The artefact was able to set a new environment into that group, developing new skills and abilities. The key role of the teacher proved to be very important to make the experience possible and engaging, stimulating different competences in the educational framework. Xkè? is not a research centre, but a centre for applied activities.

For this reason, we believe we represent a very good trial test for new scientific findings that Universities or research centres can set on our stage. We noticed that this new set was also able to let the girls perform better than boys (see OECD about

Italy 2018 – Education at a Glance) and in Italy rural areas are more disadvantaged than cities. Moreover, a relevant component of educational poverty - the Italian Save the Children Report 2018 gives back an hard scenario - affects deeply performance. Is also noticed (even in EU science networks – Ecsite) that all informal education places can play important role in inclusion and gender issues.

## STRATEGY: TEST KNOWLEDGE BY COOPERATING

The main strategy was to design a tool to directly impact students' self-efficacy and a flowchart to indirectly impact students, through their educators (see following chapter).

The game tests the knowledge of students in various fields (art, technology, mathematics and science) while encouraging them to learn by working together. The class is divided into four groups which play the game simultaneously. All groups have to complete a level before they can move on to a higher, more difficult, level.

In each game session, each group has to reach its own milestones for the whole class to move to the next level of difficulty. This ensures a certain degree of cooperation between students from different groups. The objective of each group of players is to build a Platonic solid. On each solid, part of an enigma is displayed. The class has to solve the enigma together to move on to the next level of difficulty. To build its solid, each group has to win its parts (faces) by correctly answering questions on various subjects, successfully completing experiments, or passing memory tests. **Each group has to reach milestones to win faces.**

As the game proceeds, the teacher's role is to participate and encourage participation in a fun, informal yet content-rich experience. The groups take turns to ask and answer questions, with one group drawing a card (each card contains a question and answer) and another answering.

The teacher can intervene during the question-and-answer process to stimulate wider discussion on the subject addressed by the question (as playing time permits). The teacher also plays a special role in the experiments and memory challenges: each time an "Experiment" or "Memory Challenge" card is drawn, he/she reads out the instructions for conducting the experiment and using the necessary materials, then supervises the groups as they conduct their experiments.



Figure 8. Distribution of the level of skills and activities in the game

From the Vademecum given to educators/teachers about the table play game content.

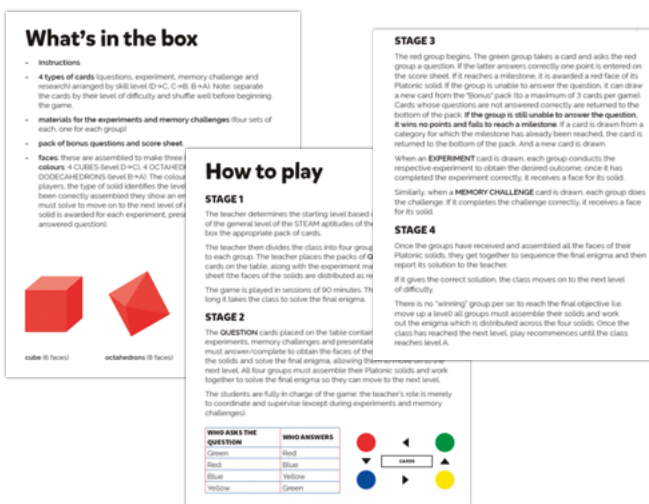


Figure 9. Instructions given to educators

From the Vademecum given to educators/teachers: steps guide of the game phases

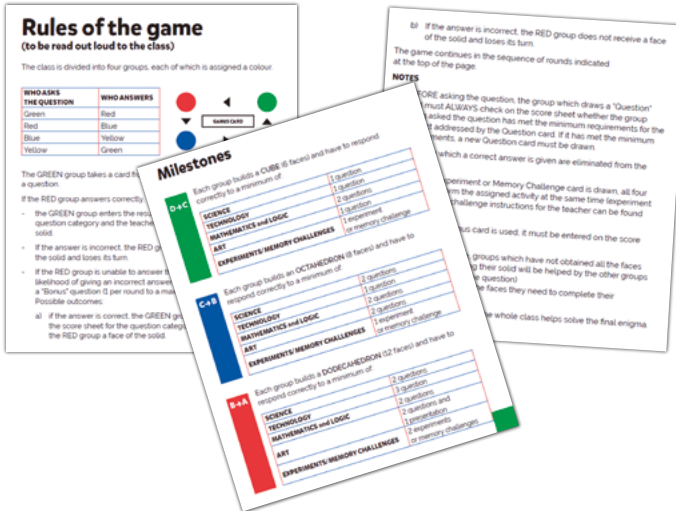


Figure 10. Rules of the game for children

## XKÈ? LABS METHOD FLOWCHART

To stress the path between Xkè? and the schools, and to give a tool of how hands-on activities can be taken into class, we set up a flowchart.

- 4 moments for a path: the activity is divided in 4 moment (different length) to give rhythm and to have a framework.
- Question as tools to make the school group work together.
- Questions as tools to make the experience flow, to share, know content, discover that there are not wrong questions.
- Questions as a frame in which all "why?" are possible if they are organized and structured.

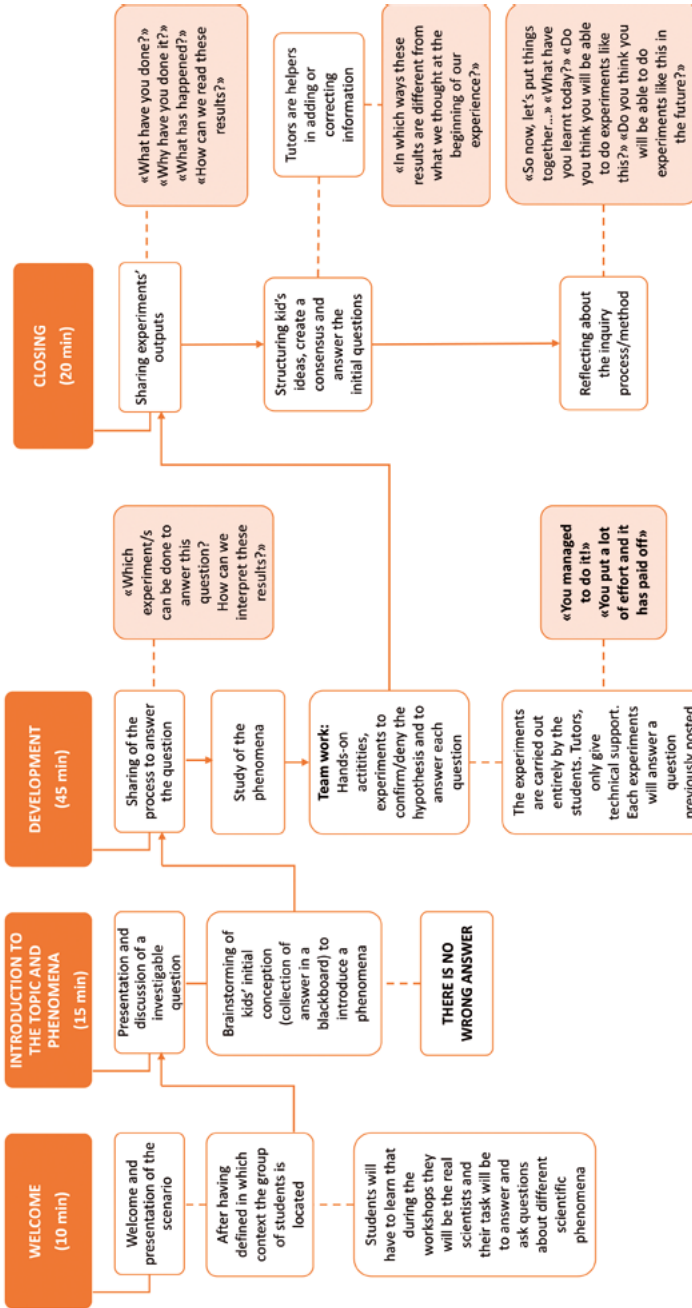


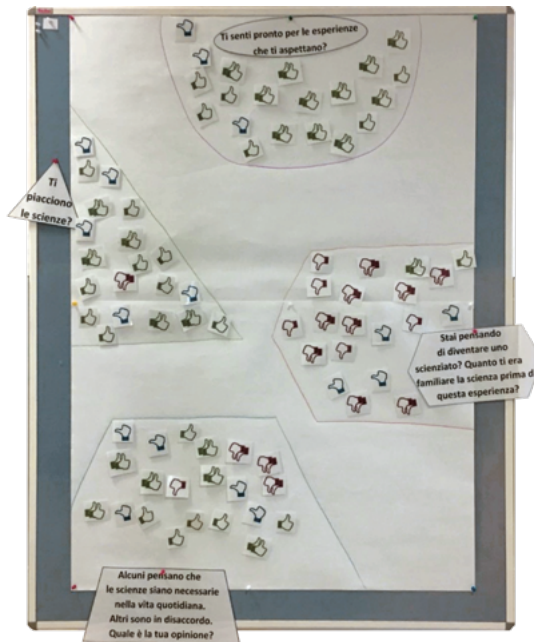
Figure 11. Flowchart of the Xké? hands-on activities

## ASSESSING PARTICIPANTS' SELF-EFFICACY IN STEAM BEFORE AND AFTER LABS AT XKÈ?



Xkè? also provided a short questionnaire to the visiting students, before and after the activities, to measure if the experience was able to raise their feeling toward science and self-efficacy. The outputs were not able to give a significant feedback, maybe because the timeframe was too short or because of the distance between the labs and the idea of science. Despite the quite disappointing feedback, the students' questionnaire helped to better orient future activities to bridge the gap between science and young generations, by using tools and languages able to speed this process.






Different tools were used: initially a blackboard with stickers thumbs up and down (team work). In the process of gathering these data, was evident that the blackboard as a unique repository wasn't effective.

For this reason, a new tool was provided and data gathering with written questionnaires to be filled (individual work).










**Figure 12.** Representation of the data gathering at Xké?







27/03/2018  
Institute  
I.C. Orbassano I  
Class: 2 A


BEFORE					
Are you able to do what are you going to do?					
How curious you are on science?					
How science is closer to you?					
Some thinks that science is necessary for their daily life. Do you agree?					
Are you considering to become a scientist?					

Legend:

- YES A LOT 
- YES 
- SO and SO 
- NO 
- NOT AT ALL 


27/03/2018  
Institute  
I.C. Orbassano I  
Class: 2 A


AFTER					
Were you able to do what was expected?					
After this experience, how curious are you about science?					
Some thinks that science is necessary for their daily life. After this experience, do you agree?					
How science is after this experience closer to you?					
Are you considering to become a scientist?					

Legend:






- YES A LOT 
- YES 
- SO and SO 
- NO 
- NOT AT ALL 

Figure 13. Questionnaires for individual data gathering



### Disappointing results

Xké? Underestimated the fact that an experience (even special) that lives in a short time frame cannot make a relevant difference in the questionnaire.

One shot experience was too challenging to give back a real feedback.

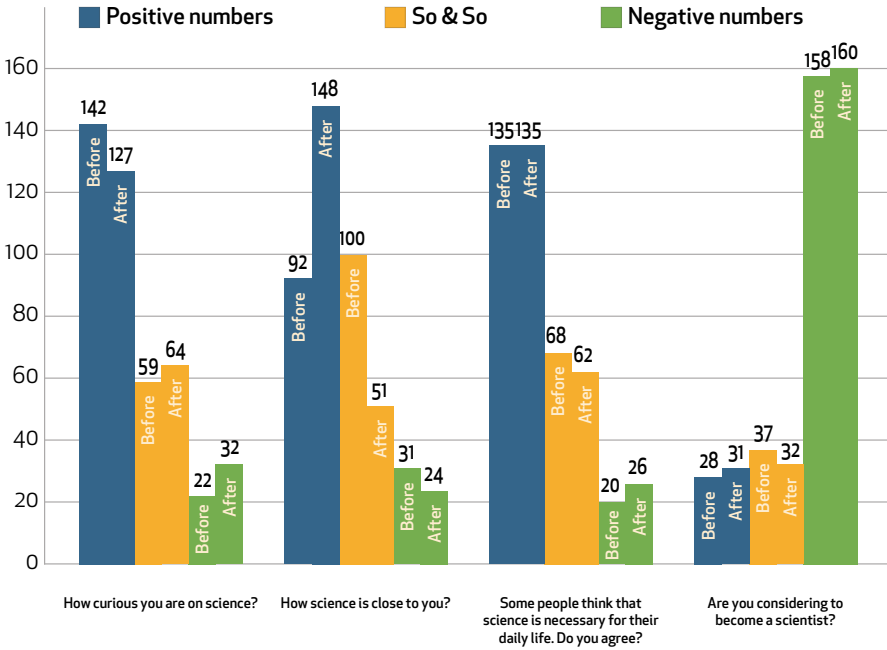


Figure 14. Results of the questionnaires at Xké? Addressed to children

## ASSESSING THE OUTCOMES RELATED TO THE EXPERIMENTAL ACTION OF THE ARTEFACT ADDRESS TO THE STUDENTS

The impact assessment was done by submitting a questionnaire to the teachers of the classes that participated into the trial process. Few questions referred to the experience of the table play game in the class. The closed-questionnaire with a predefined scale of values was given to 22 teachers (2 for class).

The compilation by the teachers took place after the use of the board game in the classroom (made by Xké? and donated to the participating classes). 3 or 4 play

sessions during class time or after school have been practiced in order to test the artifact and verify its appreciation and effectiveness.

The results collected proved to be good (average 4.5) whose lexical rendering can be summarized as follows: The game proved to be very interesting. Some topics had already been dealt with in class, others not. This allowed a different approach to the new concepts and their deepening.

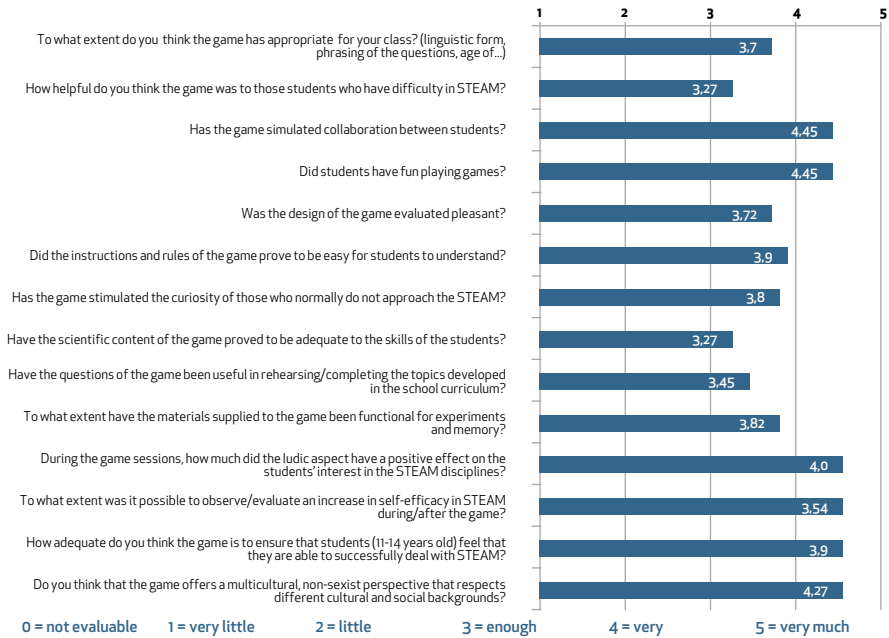
The activity allowed to approach the sciences in a playful and hands-on way, revealing a good tool to involve even the less enthusiastic students (often even the more disadvantaged, as literature recalls). “It was not always easy to deal with the questions proposed by the game, but this allowed to use different strategies such as the use of the interactive white board and other devices available at school”.

The two main feedbacks from teachers were focused on efficacy of the tool and on the effect of the process on inclusion. The artifact has been a stimulus for students who have consolidated specific concepts and in-depth topics already covered. The natural competition between groups has raised the interest of the students was replaced by the need to cooperate to achieve a common result. The self-efficacy of the disadvantaged students has increased thanks to the use of ludic approach and hands on activities into the process of learning.

The questionnaires were submitted to 22 lower secondary school teachers.

Results of the survey given to teachers.

## SURVEY WITH THE TEACHER AFTER THE USE OF THE GAME IN THE CLASSROOM



**Figure 15.** Results of the teachers' questionnaires (22 lower secondary school teachers)

## A CHANCE TO GO DEEPER IN THE CONTENT

A senior tutor voice



**Figure 16.** Serena Berbotto feedback (Senior tutor in charge of after school activities)

“The activity has been also piloted in after school programs: the results were very good. The idea of playing with science was also the chance to review and sometimes disclosure new knowledge. The competition between teams was particularly strong from the very beginning, and this was crucial to keep their focus. The group was really mixed, by gender and by diversity (fragile and problems with attention disorder); the rule games were perfectly understood and respected.

Not all the topics of the game were part of the students’ curricula (belonging mainly to tech and science schools), as institutes can set part of their program autonomously, within a general and national frame. The bonus cards were very helpful in overcoming these problems and in refreshing the group the on field activities taken at Xkè? The other parts of the game (memory card, small research and experiments) were very engaging and raised the ability of cooperate, “forcing” the students to help each other.

Some levels took longer (D to C and C to B levels, up to 5 hours), as they gave the opportunity to go deeper in other topics (especially math and science, making experiments and showing videos in class); this suggests that the activity can be divided in 2 part. The role of the tutor/teacher is crucial to follow the path of the game and to orient the activity into specific moment following the steps of the game.

The group gave some feedback: expand the practical activity; give more time to the part of public speaking (tell the group about your findings). Finally they admitted that their knowledge in science was greater than they expected: this is a way (through experiences) to raise self-efficacy”.

## CONCLUSIONS

Lesson learned:

- Use the right tool
- Time is needed
- The process more than the product

This project gave Xkè? the chance to set a new tool, using the hands-on approach that makes the Centre so special in Torino and also in a bigger (national and international) panorama. The lesson learned for Xkè? (to be shared primarily

with partners) is that choosing the right tool is crucial to make a success out of the content. A second lesson learned very important is that autonomy is fundamental to raise self-efficacy.

The table play game reached the public in the right way and engage 11/13 year-old students from the very beginning. The process of cooperating and competing, the ability of raising self-efficacy is more important than the final product (the solid). *It is crucial that the teacher knows very well the structure and the organization of the play table game; they should study the game's questions and answers in advance to be as supportive as possible, without stepping into the game.*

Cooperation with the teacher is crucial for a good result, especially in guiding questions that may refer to general knowledge, for this reason it is very important that the teachers study for the game in advance. But the most important thing is to grant kids the autonomy to play, discover, make mistakes and improve. Every experience takes time: like bread dough needs time to rise, self-efficacy needs time to develop.

#### KEY MESSAGES FOR EDUCATORS

- **To raise self-efficacy, autonomy is fundamental**
- **A good tool/method can make the difference**
- **Teachers as supporters**

## FUTURE STEPS

This project/experience gave us the chance to set up a new tool. The table play game proved to be a very effective platform to keep together a class group on different dynamics, where also the more fragile could be active part of the process, where competition is stepping back for cooperation, where equity issues (gender) can be addressed as girls play more active roles into the process.

In the future, this piloting can be scaled up in more diverse environments, after school programs, in order to give continuity to a different, more inclusive approach to stem and steam.

## TO KNOW MORE

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