The 14th International Congress on Mathematical Education
Shanghai, 12th –19th July, 2020

ACTION-RESEARCH GROUP ON GO GAME AS CLASSROOM PRACTICE TO LEARN MATHEMATICS AT PRIMARY LEVEL

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We present a classroom research developing resources to teach mathematics in French primary school by using the game of Go. Go players, teachers, searchers meet at university to produce teaching resources, to implement them in the classroom and to have a reflective phase to evaluate and improve the resources. The aim of this classroom research is to study the opportunities of the game of Go to learn mathematics and to propose a teacher training course to implement the game of Go in French primary schools in accordance with the French syllabus.

THEORETICAL FRAMEWORK

Using the terminology of Chevallard's anthropological theory of didactics (Bosch & al. 2006) we consider that the Strasbourg Go Club (Strasgo 2019) is an institution that produces the knowledge of the ways to play the game of Go. In the research group, a post-secondary mathematics teacher, member of the Strasbourg Go Club and a secondary school teacher, captain of the French Go team, bring this knowledge about the game of Go. French primary school is another institution where the mathematical syllabus is taught. About ten primary school teachers and a university didactician bring this knowledge about the teaching of mathematical syllabus. We study the double transposition of the knowledge of game of Go and of the mathematical syllabus in the French primary school. We study different teaching tasks offered in classes, the way of doing these tasks and how this way of doing is justified, here from the point of view of the game of Go and from the mathematical point of view. The material used in game of Go (board and stones) enables to work in a new register of representations. "Mathematical comprehension begins when coordination of registers starts up. […] Mathematical thinking processes depend on a cognitive synergy of registers of representation" (Duval 2006, p.126). We assume that the context of the game of Go will help to learn mathematics.

METHODOLOGY USED

This research takes place in an IREM (Research Institute of Mathematics Teaching): "Independent from, but close to mathematics departments, these university structures welcome university mathematicians, teachers, teacher educators, didacticians and historians of mathematics who collaboratively work part-time in thematic groups, developing action-research, teacher training sessions based on their activities and producing material for teaching and teacher education" (Artigue & al. 2019 p.13). We use the methodology of didactic engineering: "a phase of preliminary analysis and design, a phase of teaching experiments, and a phase of retrospective analysis" (Margolinas & al. 2015, p.901). Once per month the research group meets with the following phases: playing and learning the game of Go, reporting about the experiments in the classes and sharing

produced resources, reflecting on the experiments and conceiving new experiments to implement before the next meeting.

EXAMPLES OF DETAILS OF THE EXPERIMENT

Short presentation of the game

First let us introduce shortly the game of Go. It is a strategy game for two players; one player has the black stones and the other one the white ones. One player takes his turn to place one stone on a vacant point of intersection of the board. The stones are not moved. This player captures a stone or group of stones of the other colour when they are surrounded by his stones on all orthogonally adjacent points. At the end of the game, the winner is the player who has the greatest number of stones on the board. We adopted the variations of the rules of the Game suggested by the Strasbourg Go Club (Strasgo 2019).

Learning of game of Go knowledge

There are different rules of the game. And Strasbourg rules (Strasgo 2019) are easy to understand and well adapted to a gradual introduction in primary school. In the first meeting of the research group different rules are introduced: the winner has the greatest number of stones on the board. The discussion is about how the pupils compare the two numbers of stones. The second rule is the capturing of stones surrounded by stones of the other color. Here different exercises are displayed: complete the surrounding of the black stones, show the surrounded group, capture stones in one or two moves.

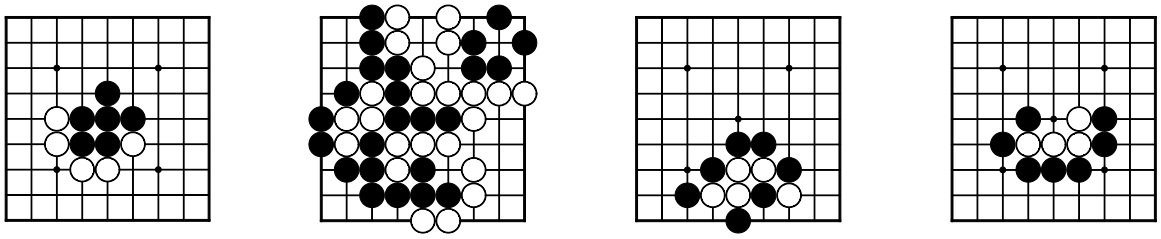

Figure 1 : Learning of Go knowledge

Another temporary rule is to consider that game is stopped when a player has captured 5 stones and at this step the players compare the stones kept on the board to know who the winner is. This rule could change later when players are sufficiently familiar with the play. In the next meeting of the research group, other rules will be learned in this teacher training to be transposed in the classroom activity.

Learning of mathematical knowledge

Grouping the stones can offer **representation registers** (Duval 2006) for different mathematical notions. Grouping in lines of same length can be a representation register of multiplication understood as the iteration of an addition (for example 20=5+5+5+5). Grouping in a rectangle can be a representation register of multiplication understood as the product of two magnitudes (for example 20=5x4). Grouping in 2 lines of 5 stones or in 1 line of 10 stones can be a representation register of decimal number system.

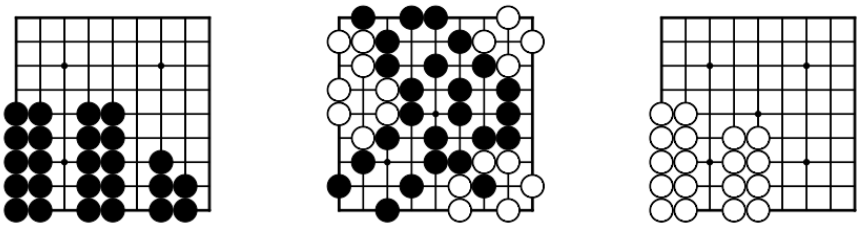

Figure 2 : Comparing without counting

Geometry can be worked with shapes. Are the stones displayed forming a line? Measure the area and perimeter of a territory surrounded by stones, etc. Other domains can be worked on: **reasoning** with game strategies, **coordinates** on the Go board, **data organization** with the results of a game of Go tournament...

Feedback of teaching experiments

Experiments show that different parts of the syllabus are being worked on, as for example in grade1, addition (complement to make 10) or lines (horizontal, vertical, diagonal). Pupils seem to easier represent the notion in the Go context that looks familiar.

Some teachers consider general benefits of the game of Go. The moral rule is important: do not cheat when playing. Pupils get confidence thanks to the game of Go. The most skillful ones are not always the best in mathematics. Pupils play with each other at the game of Go and are used to switch game partners. The social life of the class is improved.

Two modalities of work: either a couple of pupils playing with the game of Go or a collective discussion by using the classroom board. To work the situations with the classroom board helps a lot the pupils with difficulties. The difficulties can be on the game of Go side to understand the rules or on the mathematical side to understand a mathematical idea.

One teacher has worked on algorithmic and programming (a part of French syllabus at primary school) by working Go situations with Scratch programming language.

Sharing of materials and resources

One teacher adapted the counting stick (Millet & al. 2007, p. 138) to learn multiplication tables with labels representing the numbers with rectangles of game of Go stones. A software (Strasgo 2019) is available to practice at home against an artificial intelligence. Some teachers use videos on Dragon or Manga stories to motivate pupils and bring cultural context.

Figure 3: Labels with go stones representation for the multiplication table of 3

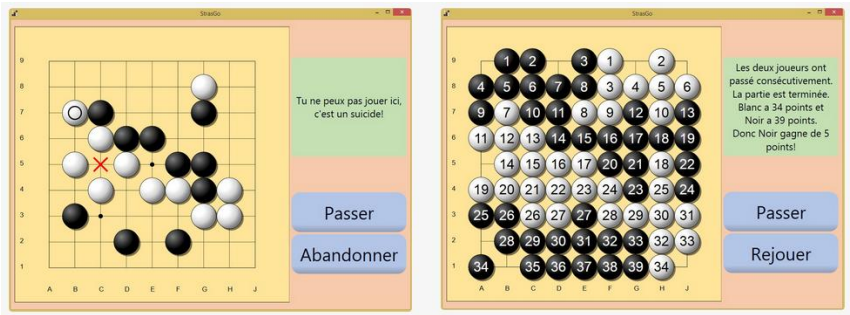

Figure 4 : A game of Go software to train individually

RESULTS AND CONCLUSIONS FOR TEACHING AND TEACHER TRAINING

With the first experiments it is possible to move the game of Go from voluntary activities outside the classroom to compulsory activities inside the classroom. **For the game of Go knowledge**, the experiments show that it is possible to learn adapted game of Go rules and to play game of Go in primary school. The progression proposed to learn the rule of game of Go has been well adapted to the variety of class situations. From the pupils' point of view the experiments show that motivation, pleasure, social behaviour are developed through game of Go activities. **For the mathematical knowledge** many parts of the French syllabus of primary school can be taught through the use of game of Go. The game of Go brings interesting registers of representation and the change of registers is a good way to understand the concepts and the procedures. For the future, the group is developing resources and new situations fitting with the syllabus.

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