Manipulatives and semiotic tools of Game of Go as playful and creative activity to learn mathematics in early grades in France

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Plan

- Context and problematic
- Theoretical framework
- Methodology
- First results
- Questions and continuation

Context

- In France Villani-Torossian report (2018) encourages extracurricular activities and clubs related to mathematics
- In France 1st didactic thesis on game of Go and mathematic teaching at primary school (Thomas Haye 2019)
- The association of the Game of Go of Strasbourg has developed for fifteen years rules of the Game of Go adapted for the children from primary school
- In France development of chess activities at primary school encouraged from the previous curriculum (BOEN 2012))

State of art

- relation between game and mathematics learning in primary school (Poirier & al 2009)
- interest of strategy games in mathematic teaching **(**Movshovitz-Hadar 2011)
- Interest of chess game : “the areas that are developed through chess are primarily problem-solving power but also logical thinking and ability to visualize in geometry” (Jancarik 2017)
- the game of Go develops the cognitive functions (Tachibana & al. 2012)
- Interest of game of Go to develop heuristic reasoning and ability to reproduce plane figures (Haye 2019)

Problematic

- The game of Go enables to learn mathematics in French primary school curriculum
- To develop activities and resources to teach mathematics through the game of Go
- To analyze didactically the use of game of Go in mathematics teaching from primary school as
  - Manipulatives tools
  - Semiotic tools
  - Playful and creative activities

Theoretical framework

- Transposition (Chevallard
  - Mathematics knowledge taught by French primary school teachers
  - Knowledge of game of Go (rules and strategies) produced by Strasbourg association of game of Go.
- Registers of semiotic representation (Duval)
  - Registers of game of Go (action with stones and Goban (Go board), oral natural (with special words), coding for representing a play ...)
  - Traditional registers of mathematics teaching

"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)

- Double approach

  « on the one hand – in a didactics-centred approach – we developed a general frame-work for analyzing teachers' practices taking into account two elements that are very closely linked, students' activities and the teacher's management of the class, [...]; and on the other hand – in a cognitive ergonomics approach – we have considered the teacher as a professional who is performing a specific job » (Robert & al. 2005)

Methodology

- Research group of IREM :

“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)

- Didactic engineering:

  “a phase of preliminary analysis and design, a phase of teaching experiments, and a phase of retrospective analysis” (Margolinas & al. 2015)

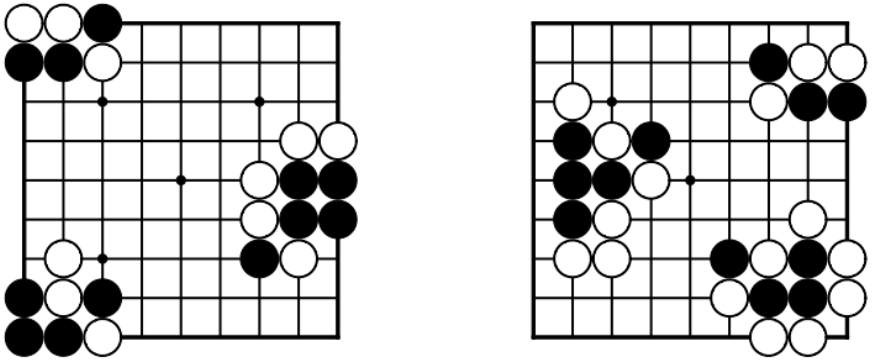
Results

Short presentation of game of Go

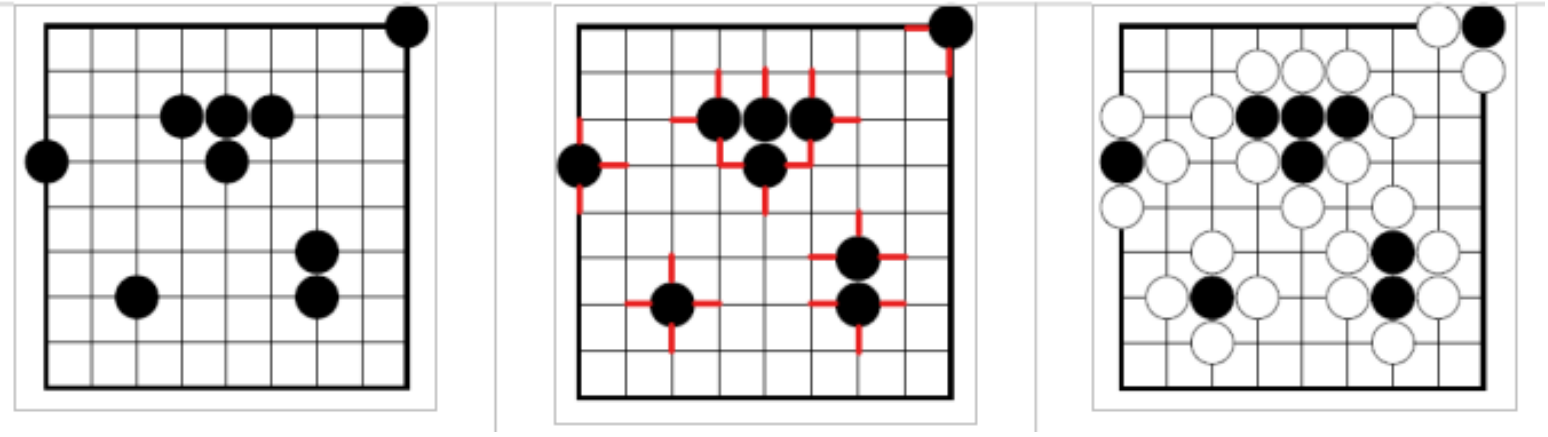
- strategy game for two players
- one player has the black stones and the other one the white ones
- the player with the black stone begins the play
- one player takes his turn to place one stone on a vacant point of intersection of the board (called Goban)
- the stones are not moved
- a player captures 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 (intermediate rule the first who captured 5 stones)

The learning of game of Go at primary school

- To recognize a surrounded territory

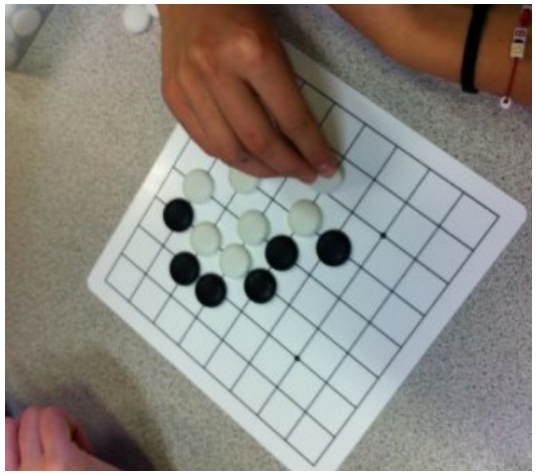


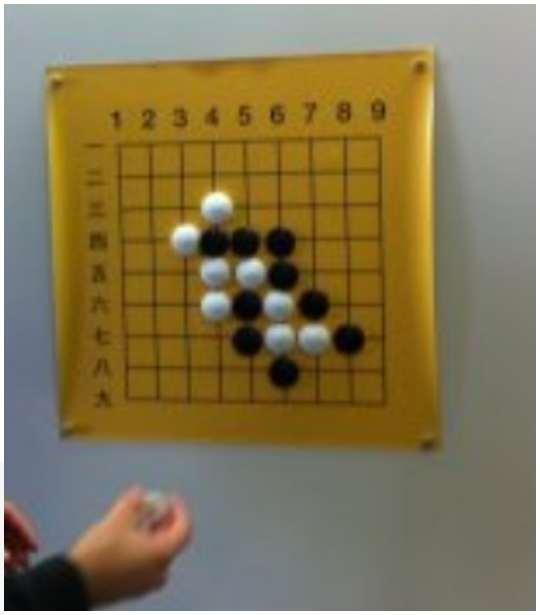
- To count the number of degrees of freedom of every set of black stones of the first Goban

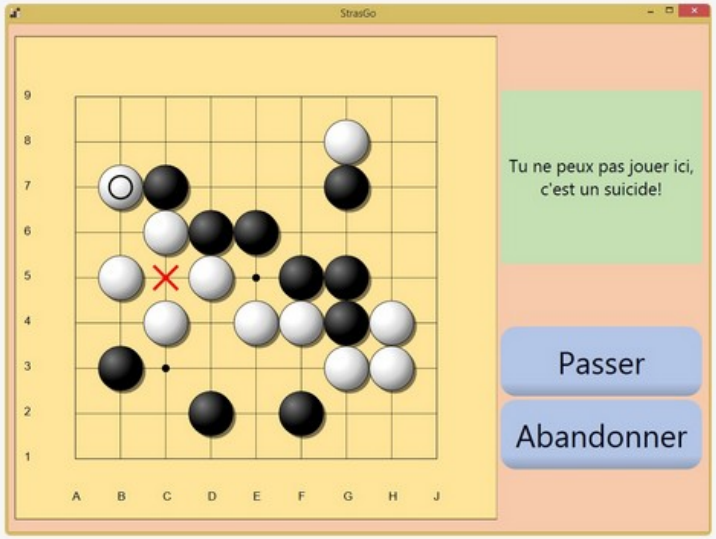


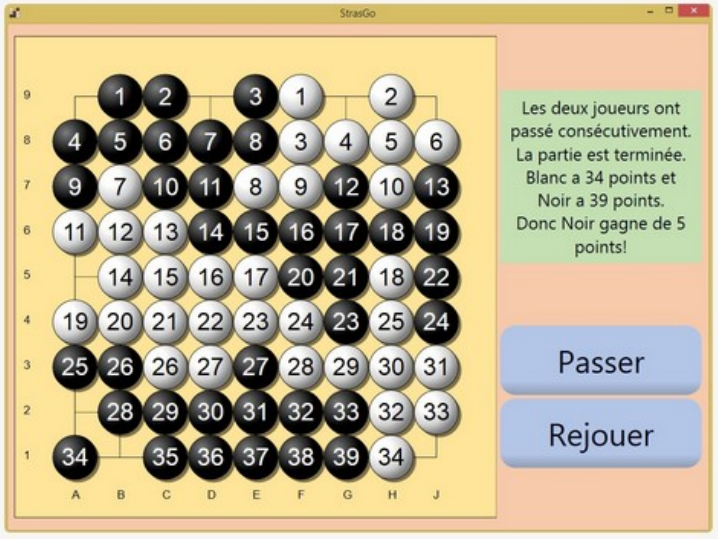
Different ways of work

- Couple of players (with eventually a referee)
- Class work at the blackboard
- Individual work with a software





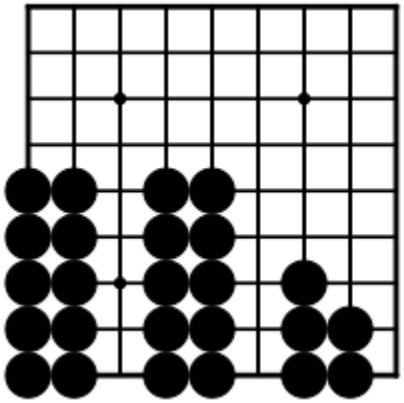


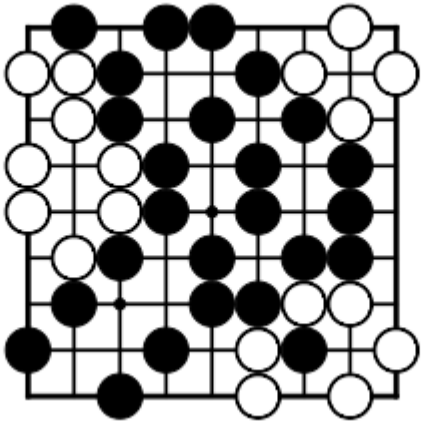


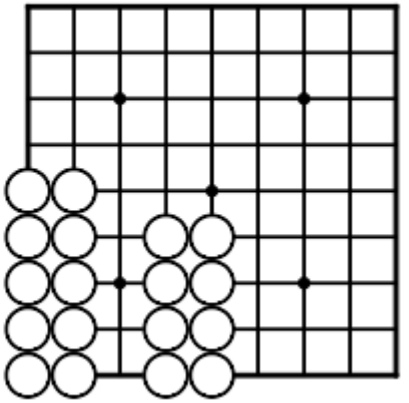
The learning of mathematics through the game of Go

The game of Go enables to learn mathematics in French primary school curriculum by using manipulatives and semiotic representations in different mathematics domain

- Examples about numbers:



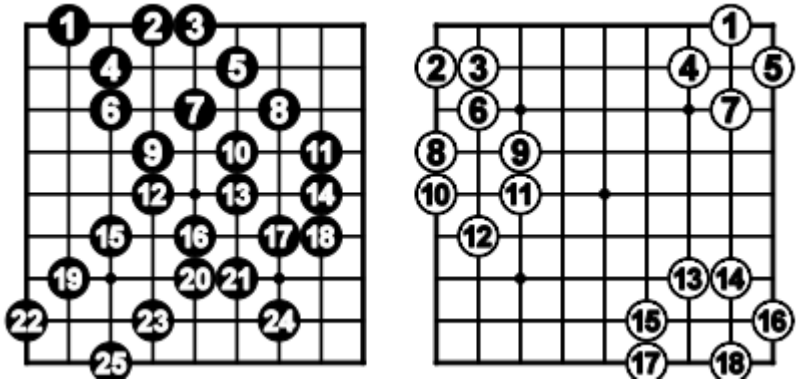




Comparing without counting

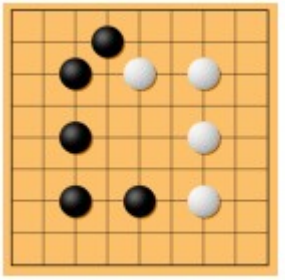
Counting by grouping

- Counting by enumerating



- Grouping in rectangle to represent a number as a product of two numbers
- Grouping in 10 stones line to represent the decimal number system

- Examples about geometry
  - Coordinates on the Goban (relative, absolute)
  - To represent geometric magnitudes (length, area ..)
  - To reproduce a play (to explain a strategy)
  - To work on symmetry (one strategy is to play symmetrically)



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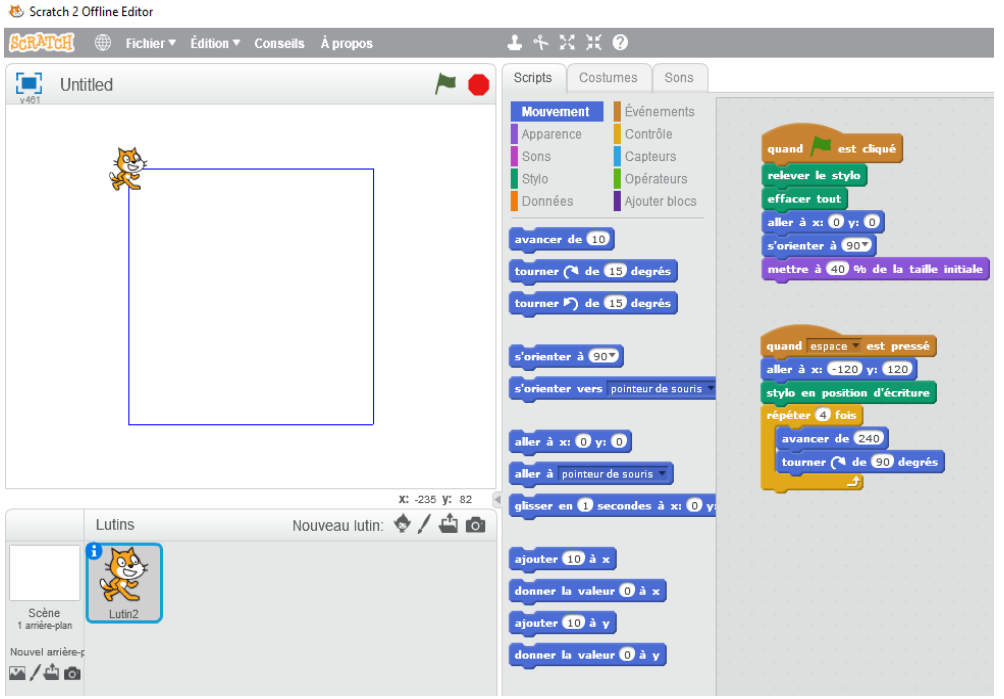
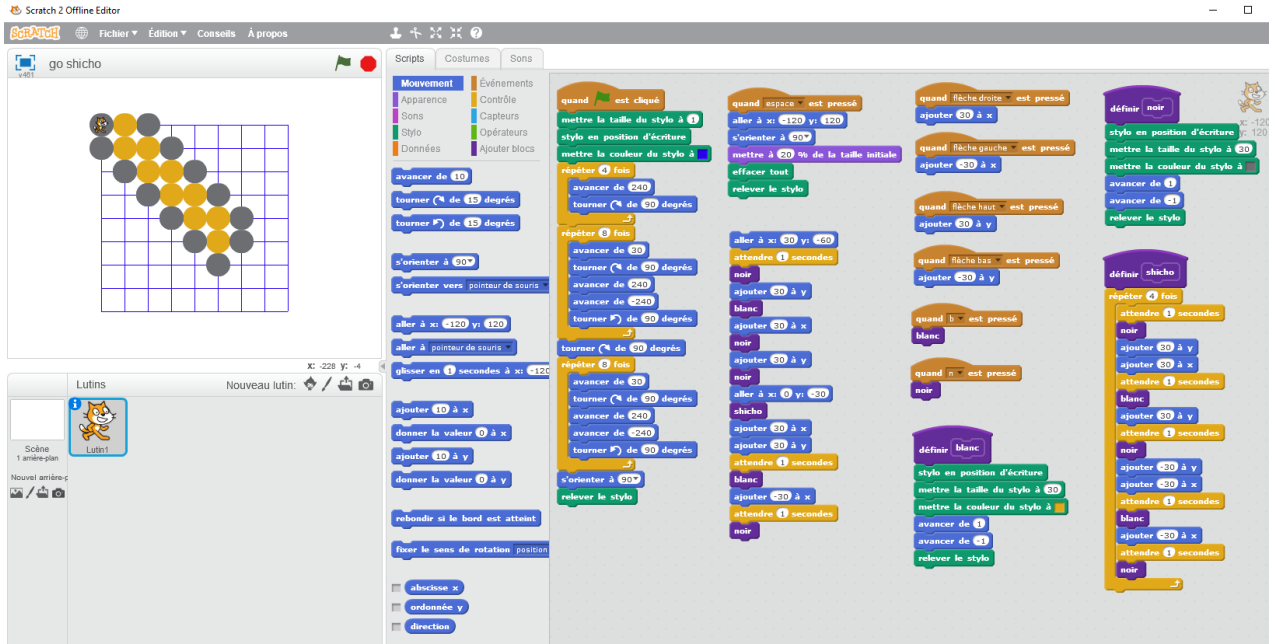
- Examples about algorithmic and programming

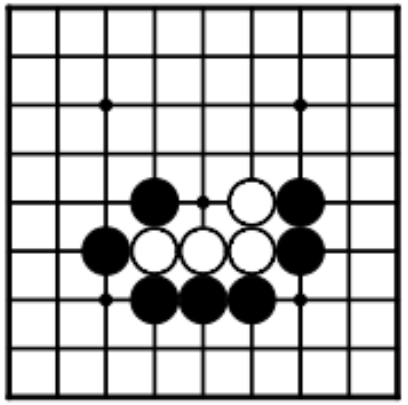
Construction of a Goban

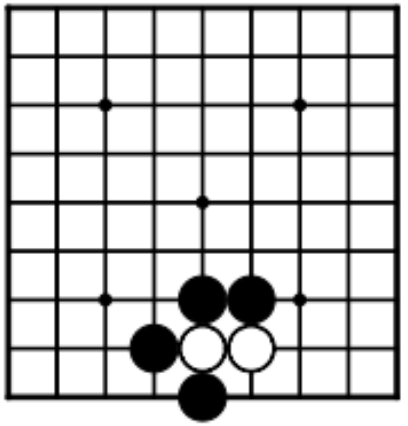




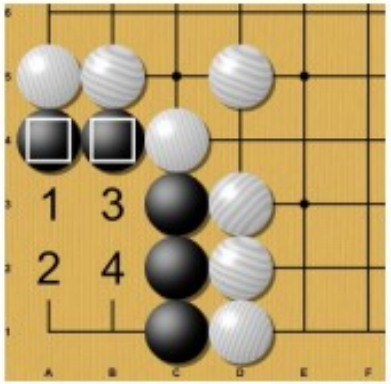
Reproduction of a play

- Example about reasoning
  - Black is playing and captures white stones in 2 turns





- White is playing. Is it possible to prevent black stones capture? (Heuristic reasoning Haye 2019)



Using game of Go representation out of a play

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

Other benefits

- **Motivation:** Teachers notice the pupils' motivation to play because the rules of the game are easy to understand.
- **Communication:** Some pupils who experience languages difficulties (because French is not their mother language) find it easier to express themselves during the game.
- **Self-esteem:** Pupils with difficulties in mathematics can success by game of Go and take confidence to work mathematics
- **Social relation:** social exchanges between pupils increase because game partners change often and organisation of tournament

Conclusion

- It is possible to play the game of Go at primary school
- It is possible to learn mathematics in French primary school curriculum through the game of Go.
- It is possible to offer activities and resources to teach mathematics using the registers of representation of the game of Go
- The game of Go offers :
  - manipulative tools (stones, Goban)
  - different semiotic registers of representation (action with stones on the Goban, written coding of these actions, oral description of these actions)

  to work on different mathematical domains:
  - number (counting, enumerating, grouping, fractions …)
  - geometry (coordinates, geometrical figures, length and area …)
  - algorithmic and programming
  - reasoning
- Variety of playful and creative activities : to learn rules and strategies of game of Go, to learn mathematics, to play game of Go (two players or individually with software or tournament)

To go on with the research

- To write resources for the different grades of French primary school
- To implement complete class sequences and record them to analyze them
- To evaluate more precisely the benefits of the use of game of Go (control group, questionnaire before and after ...)

References

Artigue M. & al. (2019). The French Didactic Tradition in Mathematics. In Blum W. & al. (Eds.) European Traditions in Didactics of Mathematics. Springer. ICME-13 Monographs.

Debellis, V., & Goldin, G. (2006). Affect and Meta-Affect in Mathematical Problem Solving: A Representational Perspective. Educational Studies in Mathematics, 63(2), 131-147.

Duval, R. (2006). A cognitive analysis of problems of comprehension in a learning of mathematics. Educational Studies in Mathematics (2006) 61: 103–13.

HAYE, T. (2019) Etude des conditions et des contraintes d'implémentation d'un jeu de société à l'école, comme vecteur d'apprentissages mathématiques. Cas du jeu de Go au cycle 3. Thesis. Universiy of Montpellier.

Jancarik Antonin (2017) The potential of the chess environment in mathematics education – pre-service teachers' perspective. In J. Novotna, & H. Moraova (Eds.), International Symposium Elementary Maths Teaching. SEMT'17. Proceedings, 225-235. Prague : Charles University, Faculty of Education.

Margolinas, C., Drijvers, P. (2015). Didactical engineering in France; an insider's and an outsider's view on its foundations, its practice and its impact. ZDM Mathematics Education (2015) 47: 893–903.

Millett, A., Brown, M., Askew, M. (2007) Primary Mathematics and the Developing Professional. Springer.

Movshovitz-Hadar, N. (2011). Bridging between mathematics and education courses: Strategy games as generators of problem solving tasks. In O. Zaslavsky & P. Sullivan (Eds.), Constructing knowledge for teaching secondary mathematics: Tasks to enhance prospective and practicing teacher learning, 117-140, Springer.

Poirier, L., Novotna, J., Godmaire, C. (2009). Games and learning mathematics. In J. Novotná, H. Moraová (Eds.), International Symposium Elementary Mathematics Teaching SEMT'09 (pp. 277–278). Prague: Charles University, Faculty of Education.

Robert, A., Rogalski, J. (2005). A Cross-analysis of the mathematics teacher's activity. an example in a French 10th-grade class. Educational Studies in Mathematics, 59: 269–298

Strasgo (2019, March 28) An application brought to you by the Strasbourg Go Club to discover the game of Go. Retrieved from http://strasgo.gostrasbourg.fr/index_en.html .

Tachibana Y, Yoshida J, Ichinomiya M, Nouchi R, Miyauchi C, Takeuchi H. (2012) A GO intervention program for enhancing elementary school children's cognitive functions and control abilities of emotion and behavior: study protocol for a randomized controlled trial. Trials 2012. 13:8.