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G.R.I.M. (Department of Mathematics, University of Palermo, Italy)

CHESS AND MATHEMATICS EDUCATION: SEARCHING FOR THE LINKS

Giuliano D'Eredità[1] and Mario Ferro
University of Palermo, G.R.I.M.

ABSTRACT

This paper is concerned with chess and mathematics education; we realized an investigation in a low secondary school in Agrigento (Sicily-Italy), in which a 30h chess course was planned; Our goal was to observe differences in students' performances in maths before and after the chess course. We submitted the students to a pre-test and a post-test. According to the PISA framework, questions were grouped by content and competence. We divided the students in an experimental group (formed by the students attending the chess course) and in a control group (formed by other students). By analyzing both pre and post test performances, we compared the performances by the students of experimental and control group, focusing also on content and competence. Unfortunately, statistics was poor, in fact 10 students only attended the chess course of 45 students participating to the investigation.
In Education in general, and for this low numbers in particular, results are to be considered with great caution. We obtained outputs in a good concordance with our beliefs and with literature, in fact the experimental group performed better in "form" and "uncertainty" items about content, and in "connection" items about competence. On the other hand, no particular improvement occurred in "quantity" and "reproduction" items. In conclusion, the links between chess practice and maths skills are sound, but are not so general. Some benefits of chess practice seem connected to using of visuo-spatial abilities by the chess players. Concerning processes, chess seems develop problem-solving skill and a more effective approach to new situations and tasks.

1. INTRODUCTION - THEORETICAL FRAMEWORK

This paper is concerned with chess and maths education.
We realized an investigation in a low secondary school in which a 30 h chess course was planned. We are interested in deepening possible links between chess practice and maths skills and abilities. It is not easy to realize an adequate investigation, because of multiple reasons. First, we know that "there are no proofs in Maths education" (Schonefeld), and also it is very difficult to find appropriate sets of students and appropriate chess courses. Last but not least, realizing good, reliable tests with appropriate methodology. Keeping in mind these reasons, we focused just to reinforce some beliefs about chess as an integrative tool in education, as emerged in literature.
Various works were published about our topic, and different types of skills were considered, like cognitive skills, or social, with reference to specific fields also.
Some basic items were sharply outlined. Several studies were dedicated to scholastic context, considering groups of students engaging in chess practice and their educational path. There are also studies on non-scholastic contexts, like chess clubs or population in general.

Interesting resuls were obtained. The big project "*Learning to think*", (Venezuela 1979-83, cfr. FIDE report 1984) showed general, positive effects, i.e. performance in generic tests, like QI valutation before and after chess practice (4-5 months). The QI was measured by *Wechsler Intelligence Scale for Children*. Other investigations were made about cognitive development. Very interesting the research conducted in Belgium by Johan Christiaen on 10-years old childrens, in which the experimental group performed better than the control one. Experimental group children had 42 hours of chess practice.

[1] Doctoral Course "Storia e Didattica delle Matematiche, della Fisica e della Chimica" University of Palermo

Very important and well structured, in my opinion, is the study *"Scacchi : un gioco per crescere (Chess : A game to grow) "*, realized in Italy (Piemonte Region) in 2007 by Turin University (Trinchero e Piscopo), in which effects of scholastic chess practice were examined with respect to cognitive factors connected with the logical skills of children (8 primary school classes). In this study results highlighted good performances by the experimental group, in particular *it was noted that improvements of experimental classes are concentrated on items requesting maths abilities (sum, subraction, moltiplication, division) and capacity to extract rules from a situation and to apply them.* It is fundamental, in our opinion, what the authors highlight regarding the use of chess as a tool to improve cognitive skills. It concerns the duration and tipology of the chess practice, in particular the recreational approach; synthesizing, educational actions involving chess can't be based only on assumed intrisec validity of chess practice, but these action need an appropriate course embedded in the context (milieu). This holds true also in a more general sense, in fact a research in maths education must take into account that every activity depends strongly on context, as stated by Schonefeld (2000) :... *the subject of research (a teaching method, or a particular content, etc), i.e. a curriculum is defined "implemented curriculum " only through the operations the teacher does in the classroom (or laboratory, etc) using materials (related to subject), and all connected pre-operations, and It is a strong relation between curriculum and context, you have to consider to evaluate the effectiveness of the curriculum itself.*

Other interesting researches estabilished relations between chess skill and other abilities, like in *Chess and Aptitude* (Frank 1974). As Ferguson pointed out, *"This result tends to demonstrate that chess skill it is not due to the presence of one or two abilities in an individual, but a great amount of actitudes work together in chess"*. More in depth, other researches highlighted good results about problem-solving abilities, reading skills, and about memory and verbal reasoning. Very relevant also results obtained by Ferguson about critical and creative thinking.
As mentioned above, ou principal focus is chess and maths education.
There were some specific studies about. The research "Comparative study on learnings in maths" was realized by Louise Gaudreau in Canada (1992), involving 3 groups of 10 years old children, in total 437. The experimental group had better performances concerning problem solving tests, but not in basic arithmetic calculations. Another important research was done by Liptrap in 4 elementary schools in Texas (1997). Abilities were considered in reading and maths using the Texas Assessment of Academic Skills (TAAS) .The experimental group performed better both in reading and maths, especially the medium-level students.
These results are encouraging, but many aspects deserve more deepening.
In fact, as stated by Gobet and Campitelli (2005) the "ideal experiment" is not realized till now (and maybe is not realizable at all..). Summing, chess and maths activate a lot of cognitive resources and very complex knowledge. They are sectors that have wide intersections, but mutual influences are not so easy to identify.

2. EXPERIMENTAL SET-UP

The investigation was realized in the low secondary school "Anna Frank" of Agrigento (Sicily-Italy), including 45 students about 11 years old. 10 of them followed a 30 h chess activity (including students' tournament). The statistics is very poor, due to the fact that the participants to the chess course had different ages, and so we focused on 11 years old students only. We aware of the limits of our sample. Our goal was to observe differences in students' performances in maths before and after the chess course. We submitted students to a pre-test and a post-test. According to the PISA framework, questions were grouped by content and competence. The pre-test consists of 28 questions, including 14 open-response items and 14 close-response. Regarding content, 13 items were classified "quantity", 8 items "Form and Space", and 7 "uncertainty "[2]. Regarding competence, we classified items according to PISA "competences clusters" (Reproduction, Connection, Reflection). But PISA is planned for 15 years old students, while our set is composed by 11 years old students, so we decided to divide our items in 2 groups only: 13 "reproduction" and 15 "connection" .

[2] For a better insight of this classification, see OCSE-PISA 2003 and 2006 official reports

Similarly, the post-test consists of 28 questions including 7 open-response and 21 close-response items. About content, 10 of them were classified "quantity", 10 "Form and Space", and 8 "uncertainty ". Regarding competence, 10 questions were classified "reproduction" and 18 "connection".

We divided the students in an experimental group (formed by the students attending the chess course) and in a control group (formed by other students). By analyzing both pre and post test performances, we compared the performances by the students of experimental and control group, focusing also on content and competence. To be more rigorous, we should consider a control group with the same pre-test performance of the experimental group, but it was no possible in our experiment, so we considered all non chess players as control group.

We realized an a priori-analysis to study the students' protocols. Such an analysis allowed us to define binary variables referred to the expected behaviors of the students (answers present on single items of protocols). The analysis is not very complex. In many cases, as in all the closed answer items, the analysis is just a partition between right and wrong answers. We aware of poor statistics, so we decided not to go into more depth in this analysis. Synthesizing, the role of processes is not very deepened in this paper, but we restricted ourselves to consider roughly the above classification about competence .

3. PRE- TEST RESULTS

In the pre-test, on average each student answered correctly to 11.89 items of 28 (42%) . About content, the best performance was obtained in "quantity" and "uncertainty" items. About competence, similar performances were obtained in "reproduction" and "connection" items.

In more detail, the students have correctly answered to 44% of the "quantity" items, 31% of the "form" and 53% of the "uncertainty" (Fig. 1). About competence, they answered right to 44% of the "reproduction" items and to 40% of the "connection" ones (Fig. 2).

Note that data are referred to the whole set of students; specific considerations about experimental and control group's performances are displayed in the following paragraphs.

FIG. 1 – Pre test performance by content

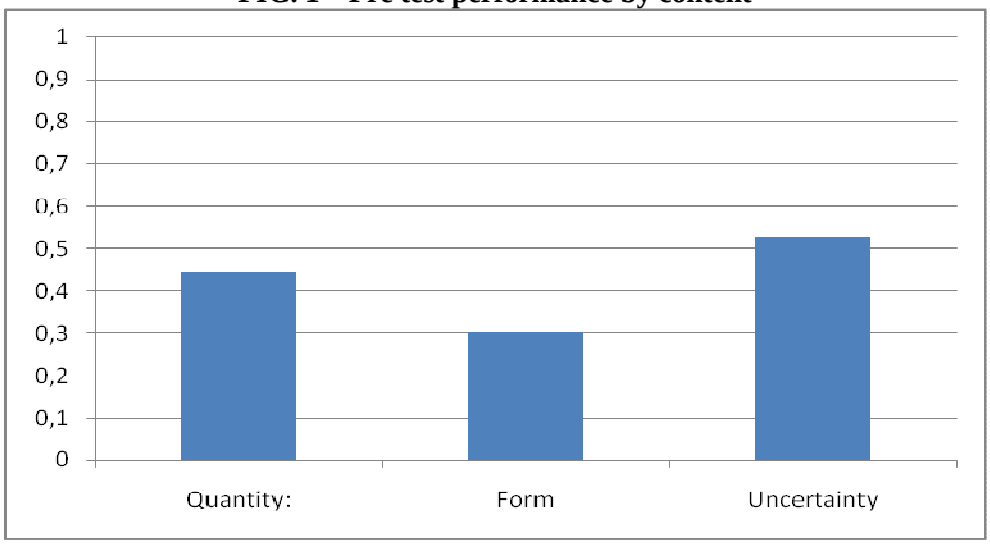
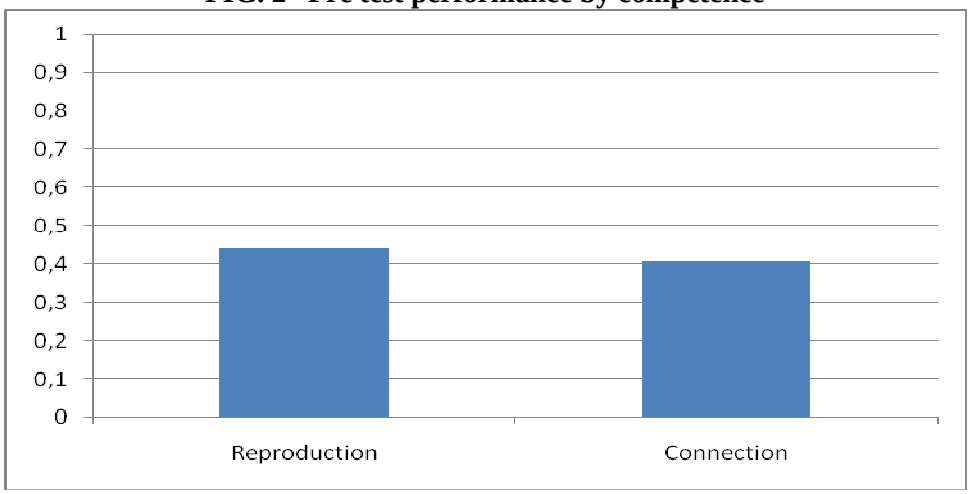


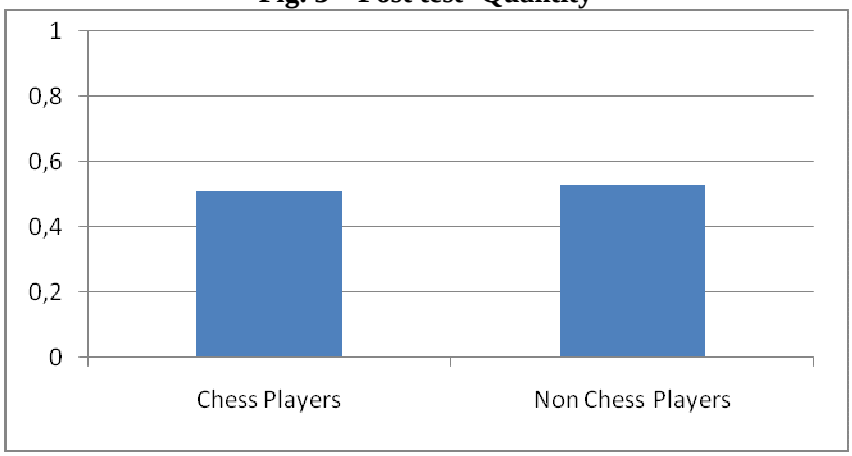
FIG. 2 –Pre test performance by competence



4. POST- TEST RESULTS AND ANALYSIS

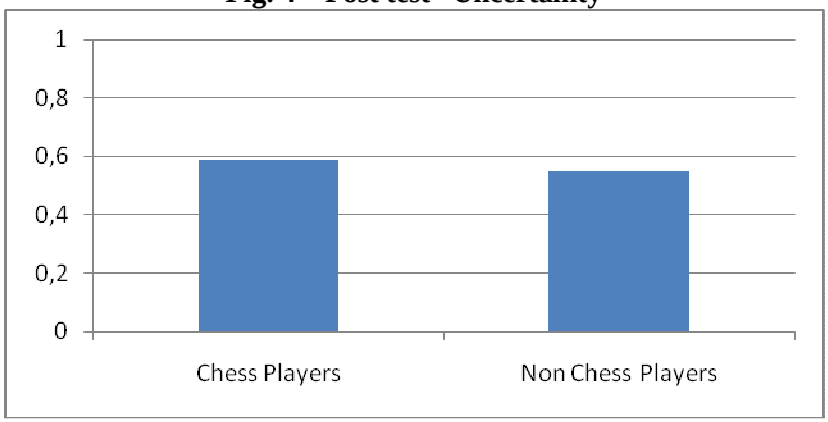
In the post-test, on average each student performed 12.5 exercises of 28. The general performance improved by 0.6, i.e. about 5% with respect to the pre-test. The improvement is normal considering that two months elapsed between tests (and a chess course !). The experimental group performed 13.5 with respect to 12.5 obtained by the same students in the pre-test, i.e. 8% better.
On the other hand, the control group reached 12.2 with respect to 11.7 of the pre-test (+ 4%).
Regarding content, the best general performance was obtained in "quantity" and "uncertainty" items. About competence, the best general performance was obtained in "reproduction" items.
Going into more detail, all students have improved in "Quantity" and "Uncertainty" items. Considering the experimental group, in "Quantity" they performed to 51% (46% in the pre-test) and non-chess players to 53% (42 % in the pre-test). (Fig.3)

Fig. 3 – Post test- Quantity



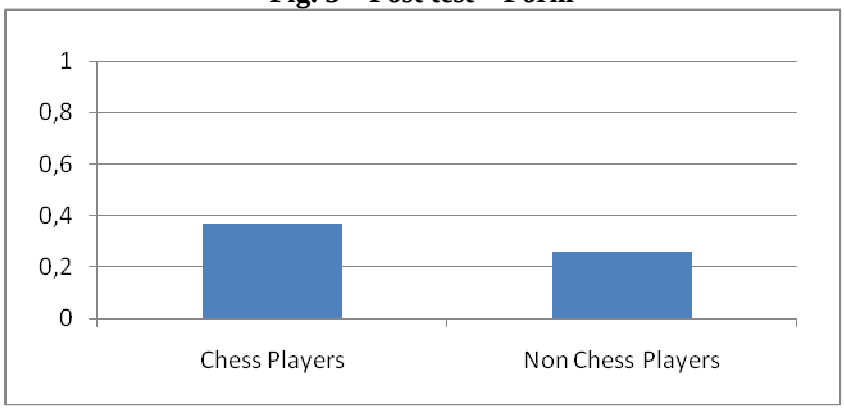
About "Uncertainty" items, the experimental group answered correctly to 59%, showing a sharp improvement with respect to the pre-test (51%), and control group to 55% (In the pre-test to 52%). (Fig. 4) .

Fig. 4 – Post test –Uncertainty



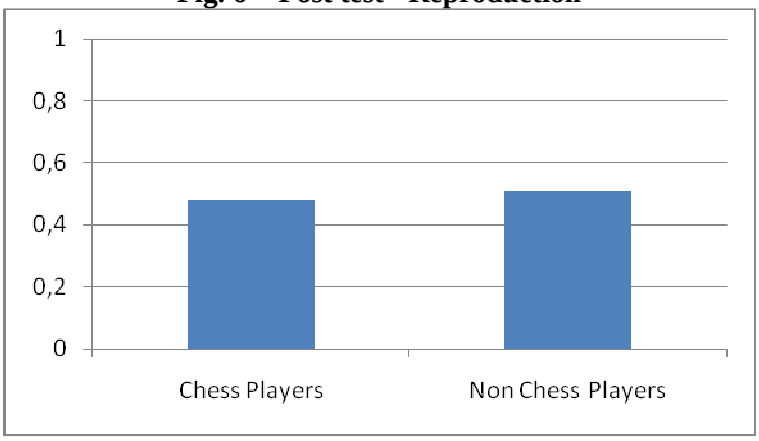
A substantial improvement was obtained by chess players in "Form" items, performing 37%, when in the pre-test they obtained a poor 27.5%, Control group went down to 26%, when in the pre-test 31% occurred for the same group . (Fig.5).

Fig. 5 – Post test – Form



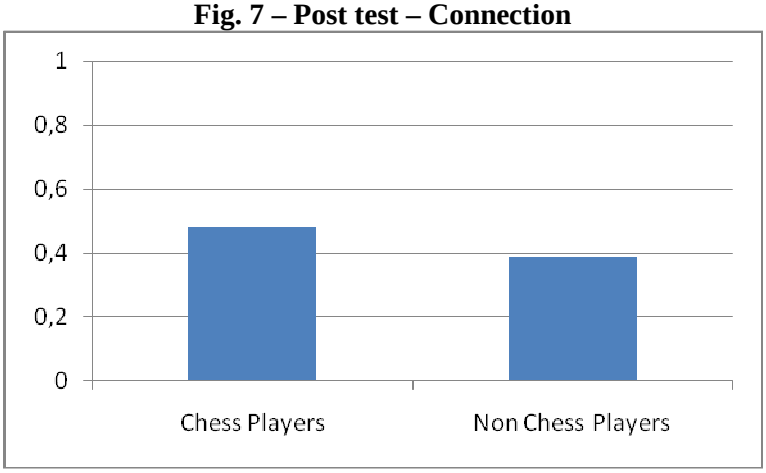
About competence, we found interesting results.
In "Reproduction" items, Experimental group improved just an edge, arriving to 48% starting from 47.7 % of the pre-test, while control group performed strongly to 51% of questions with respect to 42% of pre-test. (Fig. 6).

Fig. 6 - Post test - Reproduction



But very significant outputs resulted in the analysis of "Connection" items, where experimental group performed to 48% , starting from the 37.3% of the pre-test. Instead, the control group obtained the same 39.6% performed in the pre-test. (Fig. 7).

Fig. 7 – Post test – Connection



5. CONCLUSIONS AND OPEN PROBLEMS

The outputs of the investigation are coherent with the theoretical framework and with our beliefs about chess and maths skills.
Examining the general performance, the experimental group improved the 8% and control group the 4%. We do not consider this general improvement directly referred to chess practice, but probably it is due to the engagement in an intellectual, enjoying activity for boys and girls. To better reinforce this hypothesis, it should be suitable to consider one group more, that is a group engaged with another intellectual and amusing activity. Besides, in an "ideal experiment" (as explained in Gobet, 2005) we have to consider also the "placebo effect" related to the fact that the students know to participate to an experiment. It requires an experimental set-up that was not possible in our investigation.
Regarding content, more subtle considerations are to be made. The performance of the two groups in "quantity" items suggests that chess practice do not lead to a better skill in calculations, and in general in activities in which the application of a procedure or algorithm is requested. The sharp improvement of experimental group in "form" items suggests that the visual-spatial abilities are relevant in chess practice. Besides, during a typical 30 h chess course, including tournaments, the chess contents are at a beginner level, so the chess activity is strongly focused on elementary pattern recognition (basic endings, elementary checkmates). It would be interesting to consider various skills during the evolution of student's chess expertise. The good results of experimental group occurred in "uncertainty" lead us to reinforce the belief that chess practice is very useful in approaching new situations and data, because chess players are used to face the reality finding methods and strategies to understand it and to go ahead and proceed.
Concerning competences, the experimental group does not improve the performance in "reproduction" items, according to interpretation that chess practice is not very useful for calculation and/or mere application of a known procedure. Instead, the significant improvement in "connection" items by chess players group corroborates the idea that chess practice is very useful in problem-solving situations, stimulating both deductive thinking and the using of various cognitive or meta-cognitive resources.
In conclusion, we aware that poor statistics and using of a "non-perfect" test suggest not to give reckless assessments. We did not realize an implicative analysis and/or a factorial analysis, because of poor information about processes the test produces. Nevertheless, the outputs of this investigation reinforce our beliefs about the using of chess practice as an integrative tool for maths education.
New and more deep researches would be made to give more extensive results, and to consider interactions among factors like different maths skills and increasing chess expertise.
Another interesting topic would be the link among chess practice and the using of informatics, with particular respect to the role of new technologies in teaching and learning.

Anyway, we conclude noting that math education can consider chess as a good ally. It is noticeable that chess is an universal language, without barriers concerning race, religion, age or social position, somewhat similar to mathematics.

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