Serious Gaming at School: Reflections on Students' Performance, Engagement and Motivation

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ABSTRACT

The concept of Serious Gaming refers to the adoption of classical entertainment games for purposes other than entertainment, including learning and instruction. In this paper we report on a Serious Gaming field experiment where typical board games (such as battleship, master mind and domino) were employed with the shifted purpose of triggering and sustaining primary school students' reasoning and logical abilities. The results of the field experiment showed that: 1) there is a strong correlation between school achievement and the ability to play and solve this kind of games and that 2) motivation and engagement in game-based learning tasks is very high, irrespective of the level of achievement of the subjects. Final considerations are drawn about the potential and the opportunity of adopting the considered games to support those reasoning skills that are widely recognized as transversal to any kind of learning and thus deeply affecting overall school performance.

Keywords: Serious Gaming, Game-enhanced learning, Primary education, Motivation, School Performance, Attention, Mind Games.

INTRODUCTION

This paper presents the results of a research study in the field of game-based learning. More precisely, it refers to an experiment conducted in primary schools where digital versions of traditional board games were employed with the aim of sustaining the students' logical and reasoning abilities.

The games adopted during the experiment deeply require the enactment of thinking skills. They can be considered "cognitively responsible" (Martinovic et al., 2013) and are usually referred to as mind games (Bottino et al., 2009), brainteasers or puzzles (Kebritchi et al., 2010; Milovanović et al., 2009).

If we follow the classification proposed by Djaouti, Alvarez & Jessel (2011) we can set the reported experience in the area of Serious Gaming.

According to these authors, in fact, Serious Gaming is a label that refers to the use of "any video game for serious purposes, whether the serious dimension is or is not designed within the software" while "Serious Games is a label that refers to applications featuring both a serious and a game dimension within the software".

Actually, the games adopted, were not Serious Games in that they had not been originally designed having in mind an instructional (serious) purpose but rather for entertainment (Kirriemuir & McFarlane, 2004). Nevertheless, they were used by the authors in a school context by shifting their original purpose to serve a serious, instructional purpose and this was done without operating software modifications, in a genuine Serious Gaming perspective.

This paper, based on concrete data from the above mentioned experiment, explores the links between the possession of the reasoning abilities involved in the use of a set of digital mind games (Rohde & Thompson, 2007; Bottino et al., 2008) and school achievement.

To date, few scientific studies report experimental data confirming the possible link between school achievement and the ability to solve mind games, despite the fact that research studies in the field have evidenced that the use of digital games can:

- offer a variety of educational benefits (Sandford et al., 2006; Prensky, 2001; Hong et al., 2009; De Freitas & Oliver, 2006; Pivec, 2007);
- promote the development of cognitive and complex problem solving skills (Felicia, 2009a);
- contribute to the enhancement of school performance (Robertson & Miller, 2009; Franco et al., 2011).

The research study this paper refers to confirms such results and shows that there is a strong correlation between school achievement and the ability to play and solve digital mind games and that, however, motivation and engagement in game-based learning tasks is very high, irrespective of the level of achievement of the students involved. In the following, the context of the study is briefly presented together with the tools adopted; subsequently, the methodology of the experiment is detailed and the main results are presented as to students' performance; further reflections are proposed regarding some affective aspects of the experiment including students' engagement and motivation. This allows drawing some final considerations on the potential of mind games to support young children's reasoning and logical abilities.

SETTING THE SCENE

In the following, before presenting the methodology underpinning our study and its key results, we briefly summarize some basic aspects of the experiment including the description of the target population involved and of the tools adopted.

Target population

The experiment was conducted in twenty Italian primary schools classes in the Lombardia region: it involved 60 children in 4th and 5th grades. A further group of 20 students with certified cognitive impairment (and consequent deep, generalized learning difficulties) from a school in Genoa was also considered. This was done with the specific objective of further verifying the games suitability and potential effectiveness in respect of this target population and, also, to understand the personal attitudes of these children towards the educational use of games.

Tools adopted

The main tool adopted in the experiment was the LOGIVALI (LOGIcal thinking eVALuatIon) test, a game-based norm referenced test explicitly aimed at assessing the reasoning abilities of primary school pupils (Bottino et al., 2010). The LOGIVALI test follows a custom set-up, specific methodology to investigate and assess the possession of some specific logical and reasoning abilities; in doing so it adopts a blended approach in that it foresees the use of both digital and non-digital tools (actually playing sessions with digital games and assessment sessions with paper and pencil sheets).

In the following, we briefly illustrate the abilities encompassed by the LOGIVALI test and provide a short description of the adopted digital games.

The abilities considered by the LOGIVALI test

The LOGIVALI test takes into account a limited number (six) of specific reasoning abilities identified as crucial (Bottino et al., 2006) although they are, obviously, only a subset of the abilities required to deal with the games at hand.

The six abilities investigated through the LOGIVALI Test are:

- *Ability 1* "knowing and remembering the rules of the game": to know the rules underlying a given game and to be able to apply them in concrete game situations.
- *Ability 2* "first level reasoning": to be able to make an inference taking into consideration a single given datum.
- *Ability 3* "second level reasoning": to be able to make an inference taking into consideration two given information or game constraints.
- *Ability 4* "third level reasoning": to be able to make an inference taking into consideration more than two given information and game constraints.
- *Ability 5* "managing uncertainty": to be able to establish whether the data available at a given moment of the game are sufficient to decide whether a certain guess is correct or not.
- *Ability 6* "operatively applying reasoning abilities": to be able to implement into the game the results of own reasoning (actions should follow thoughts).

In the LOGIVALI test, the ability of making inferences is not considered as a unique skill but it is regarded and treated as an ability varying in difficulty according to the number of different data, information and constraints to be dealt with (abilities 2, 3 and 4). On the basis of the results obtained with the involved sample population (around 500 primary school students) the test was standardized and the reference norms were defined on a percentile ranking basis. In (Bottino et al., 2010) the whole LOGIVALI test validation and standardization procedure is presented. During such procedure, it emerged that the number of correct answers progressively decreased in the three stages: Ability 2 (80% of correct answers); Ability 3 (63% of correct answers); Ability 4 (46% of correct answers). This confirmed that the three abilities should be considered as increasingly complex abilities for the target population.

The digital games employed

As explained above, the test makes use of five digital mind games (Bottino et al., 2010) that fall into the category of mini-games, that is games that take less than an hour to complete (Prensky, 2005).

The five games adopted in the LOGIVALI test do not require specific prerequisites in curricular school subjects, beyond very basic literacy and, most importantly, do not imply the possession of specific arithmetical skills.

Two of the games are the computerized versions of well-known board games: mastermind (Figure 1) and domino (Figure 2).

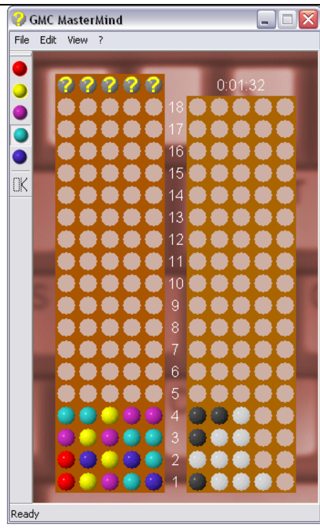


Figure 1 Mastermind
*(*http://gmoerth.freeservers.com/mm/index.htm*)*

The goal of MasterMind is to guess the sequence of a number of colored pegs that the computer has selected at random. The degree of difficulty is determined by the number of different colours that can make up the sequence (in the example, the five colours on the left-hand side) and the number of pegs that comprises it. The player starts making guesses by filling the holes at the bottom row of the left column. When a row is completed, the program shows, in the right column, how many pegs have been placed in the correct position (black pegs) and how many are of the right colour but are placed in the wrong position (white pegs).

Mastermind is strongly based on the capacity of the child to understand and use the feedback provided by the program to infer what next move might prove effective.
The game requires the player to build strategies that help to reduce the number of possible sequences, for example, trying a sequence of pellets of the same colour at the beginning, making guesses by altering the position of only one pellet, reasoning only on a subset of positions, etc..

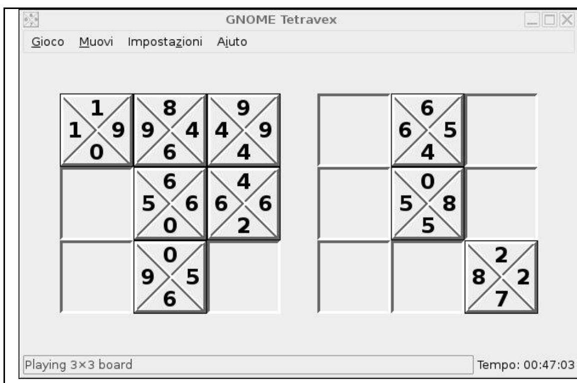


Figure 2. Tetravex
(http://live.gnome.org/GnomeGames)

Tetravex is a domino-like game whose goal is to drag in the left hand board the tiles given in the right hand board so that any two adjacent numbers are the same. Each tile is divided into four triangles marked with four numbers from 0 to 9. Tetravex has a range of difficulty levels that go from the simple (two-by-two boards) up to the very difficult (six-by-six boards).

Tetravex is a game that, at the simple levels (e.g. two-by-two and three-by-three boards), can be solved through a trial and error strategy. When the difficulty increases (that is the number of tiles is higher), this approach appears inadequate and it becomes necessary to conceive and enact an effective solution strategy.

Two of the games are board games which resemble the traditional battleship game but actually introduce further interesting features genuinely eliciting logical thinking processes (Figure 3, Figure 4).

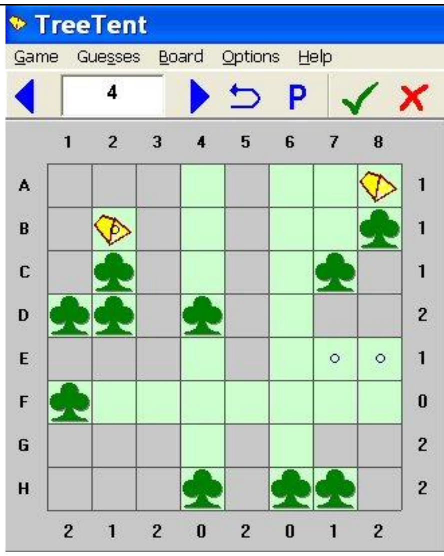


Figure 3. Tree Tent (http://yoogi.com)

TreeTent is a single-player puzzle game in which the goal is to work out where the computer has positioned a certain number of tents on a board where a certain number of trees appears. A tent can only be found in a cell horizontally or vertically adjacent to a tree, tents are never placed adjacent to each other, and for each tree only one tent can be positioned on the board. The numbers along the right and lower sides provide a clue as to the number of tents in that row or column.

Solving the game entails reasoning on available data and matching all the available information and constraints (e.g. only one tent for each tree, tents never placed adjacent to each other, etc.) in order to infer the content of the cells. This game also emphasises the need to find a strategy to reduce the complexity of the task. For instance, the task becomes much easier if the player first identifies the "peculiar case" of lines marked with 0 (lines where there are no tents).

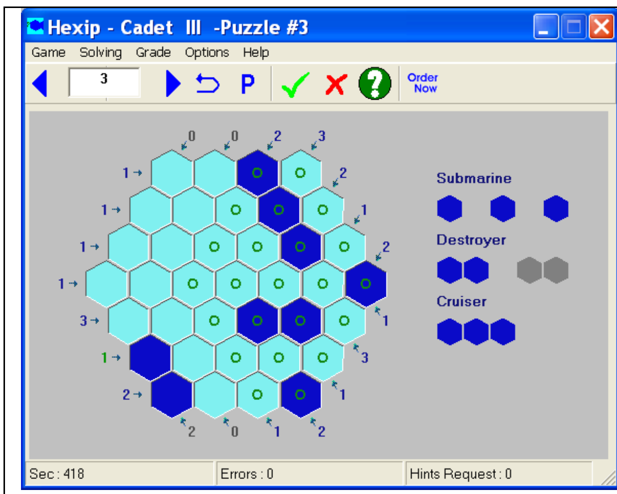


Figure 4. Hexip (http://yoogi.com)

Hexip is a battleship-type game whose aim is to find the position of ships hidden on a hexagon-shaped board. The game provides information on the number of boxes occupied by ships along both the horizontal and diagonal rows of the board (numbers outside the hexagon).

Hexip requires that students are aware of the importance of analysing given data such as the numbers outside the hexagons, and using this information effectively. Like TreeTent, Hexip requires to find ways to reduce the complexity of the task. For example, it is useful to identify first the empty rows, and, subsequently, to recognize the situations where the number outside a row corresponds exactly to the available positions. One important peculiar aspect of this game is that when the difficulty increases, the solution can be reached only by making inferences on the basis of a hypothesis/validation process.

The fifth game used in LOGIVALI test is a game named Pathological. It introduces an interesting variable in that it supports the real-time ability to adapt the ongoing logical processes to different situations according to the changing of data and related constraints (Figure 5).

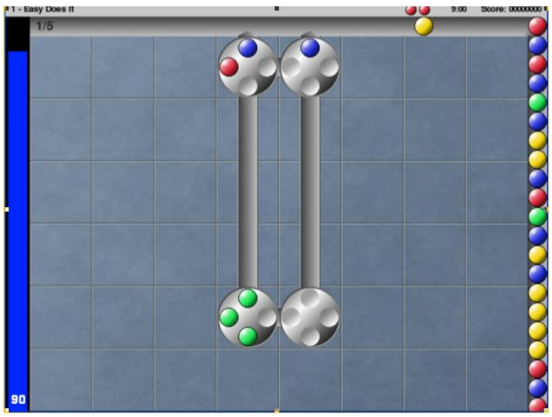


Figure 5. Pathological (http://pathological.sourceforge.net)

The Pathological game is a puzzle game consisting of marbles and wheels. The marbles are of different colours and roll along paths. Each wheel has four slots that are to be filled in with marbles of the same colour: to do so, the user clicks on the wheel to rotate it. When the wheel is completed, the marbles vanish and the wheel turns dark. Pathological is organized in progressive difficulty levels that correspond to different schemas. In order to complete each schema it is necessary to take into consideration not only the colour of the ball that is coming but also the colours of the next ones (left-hand side of the screenshot).

Since in Pathological the configuration of the board changes at each level, the game requires the students to adapt to different situations and constraints. When playing the game, the user not only needs to consider changes in board configuration, but must also take into account the colour of upcoming marbles, which can be seen in advance in the right-hand column of the interface. Anticipation therefore plays a crucial role in devising a solution strategy

The LOGIVALI test uses the selected games to verify the actual possession of the above mentioned reasoning abilities by children of the target age (4th and 5th grade students). The test encompasses five different subtests, one for each of the games employed. The test foresees an administration methodology that implies that:

a) teachers explain the selected games to the students;
b) students play individually with the five selected digital mind games according to fixed game sessions;
c) teachers monitor students at work during the playing sessions, but abstain from intervening with suggestions and help;
d) after completing the playing sessions with each game, each student individually takes a specific test on that game (subtest); test are administered by the teachers who also are in charge of making students aware of the fact that no curricular evaluation is foreseen for the test.

METHODOLOGY

As mentioned above, for the purpose of the present study 60 pupils were involved out of twenty Italian primary schools classes (4th and 5th grades) in the Lombardia region (3 for each class). They were selected following specific criteria, monitored while individually playing with digital mind games and finally the LOGIVALI test was administered.

The students were selected on the basis of their school performance and were classified in three groups according to their level of school achievement (school actual results based on the scores obtained, plus teachers' judgments) as follows:

- group A-high achievers;
- group B-medium achievers;
- group C-low achievers.

This target group of 60 students comprised three students per class: one for each group A, B and C.

In each class, the selected students were individually monitored by the teachers. The LOGIVALI test was administered during school hours individually to all the students in each classroom.

To favor the monitoring of students at work, teachers were provided with made on-purpose monitoring sheets where they were asked to record relevant data on each student's behavior, in particular on engagement and motivation.

Detailed results of the LOGIVALI test were recorded (score obtained by each student and consequent positioning of the subject in the percentile scale) and carefully analyzed.

The available data for each student thus consisted in:

- Scores at the LOGIVALI test (global score and individual scores in each single sub-test)
- Percentile analysis of performance
- Qualitative data on: autonomy, engagement and attention

For the scope of this study, all the data available through the LOGIVALI test were analyzed and compared with each student's data on school performance. It was thus possible to make some inferences on the possible correlations between students' performance in playing/solving mind games and that attributed in disciplinary tasks. In order to obtain a complete view of each student's profile, behavioral aspects (derived from monitoring sheets analysis) were also considered and the correlations with the above mentioned performances were further studied.

The research approach adopted in this study basically followed the paradigms of mixed research methodology (Burke et al., 2007; Burke & Onwuegbuzie, 2004); in fact, a combined use was made of both quantitative and qualitative approaches.

Actually, as said above, the performance of each student at the LOGIVALI test was assessed according to the percentile ranks determined by the test; subsequently, the obtained quantitative data on performance at the LOGIVALI test were compared with available data on each student's level of school achievement.

Data recorded by teachers in the monitoring sheets and referring to students' engagement and attention were, instead, analyzed by employing qualitative research methods, in particular, the direct observation research method (Herbert, 1995)

The work with the additional group of students from Genoa (those with severe certified learning disabilities) followed a different procedure and each students was constantly and individually assisted by one member of the research team during all the phases of the study (introduction, game play, test…).

In the following, while examining the results of this study we mainly focus on the results of the former group (60 students) and only use the Genoa group to make some lateral considerations on the acceptance and suitability of the proposed educational activity.

RESULTS

In the following we present the results of the students as to: 1) their performance at the LOGIVALI Test; 2) key behavioral aspects identified during game play.

As to the performance, as said above, we report data from the 60 subjects and do not consider those data coming from the 20 students with ascertained and severe learning disabilities from Genoa, mainly because data on their performance were deeply influenced by the assistants' continuous help and advice.

Performance

Performance was evaluated based on the percentile level reached. Four categories of performance were then identified:

- Poor - 25th centile and below
- Fair - from 25th up to 50th centile
- Good - from 50th centile up to 75th
- Very good - beyond 75th centile

Global performance

Figure 6 details the results of the global performance of the three groups at the LOGIVALI test: dark parts stand for low performances (actually the 2 levels of low performances: poor and fair) and light parts for high performances (actually the 2 levels of high performances: very good and good).

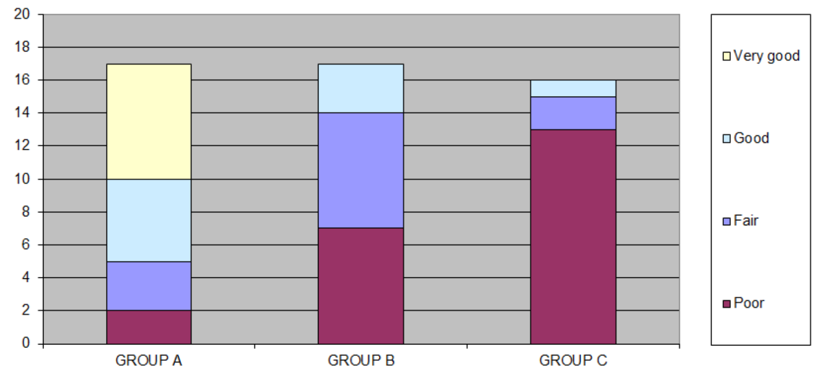


Figure 6. Performances of the three groups of students at the LOGIVALI Test

The results show that:

- Only students in group A (high achievers) have prevailing high performances at the LOGIVALI test (light parts in the figure) in respect to the other two categories where dark parts are prevailing; more than half of the students of this group perform at the two highest levels.
- The very majority of the students in group C (low achievers) perform at low levels (fair and poor); most performances of these students are at the lowest level.
- Performances of students in group B (medium achievers) are comparable to those of students in group C if we consider dark and light parts but performances at the fair level prevail on performance at poor level.

Actually, we see that performances of high and low achievers are very different (in favour of high achievers) while the medium group is situated half way between the two.

As a general observation we thus can affirm that the global results of the students' performance at the LOGIVALI Test show that a substantial consistency exists between school achievement and the ability of playing mind games.

In the following we present observations as to the specific abilities considered in the test.

Ability 1

As to the ability of recalling the game rules (Ability 1), the performance of the three groups are scaled.

As shown in Figure 7, very good performances decrease sensibly from Group A to group C. If we look at the two big blocks (dark and light parts) we see that high achievers perform better in respect to the other two groups, whose performance is still comparable.

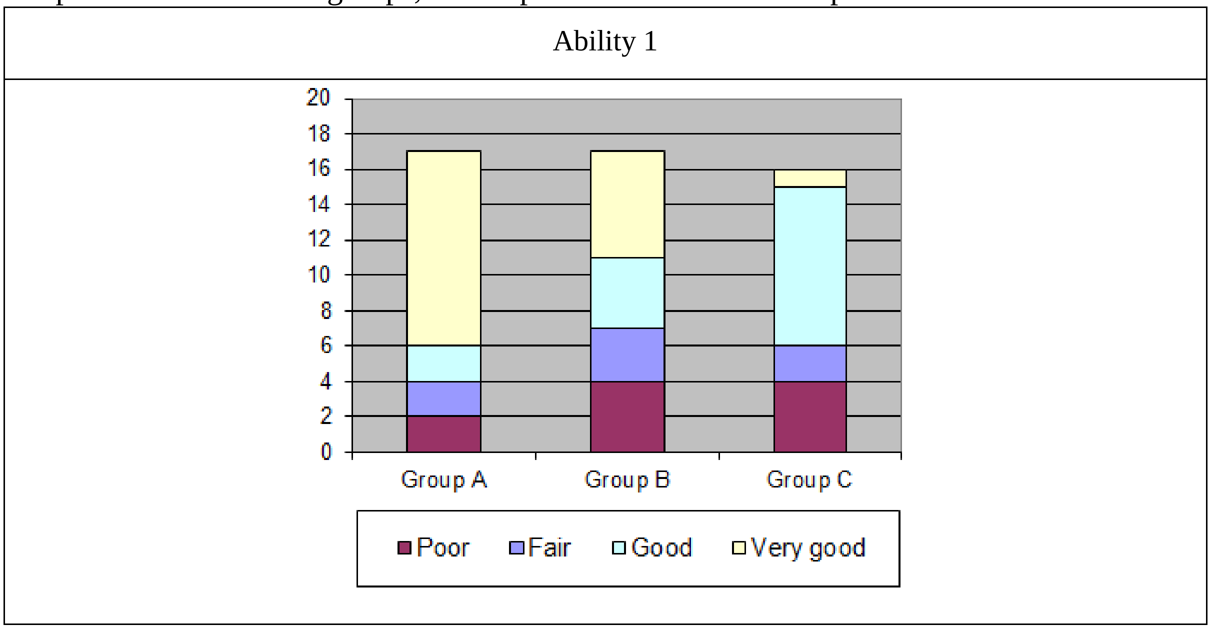


Figure 7. Performances of the three groups at the ability of recalling the game rules

Ability 2, 3 and 4- inferential abilities

As to the inferential abilities (core abilities 2, 3 and 4 of the LOGIVALI test), we see that performances of high, medium and low achievers are always scaled (with the prevalence of good performances for high achievers and of poor performances for low achievers).

This emerges from data reported in Figure 8 where the results at the three abilities of the test related to the capacity to make inferences on the basis of given data (namely Ability 2, 3 and 4) are presented.

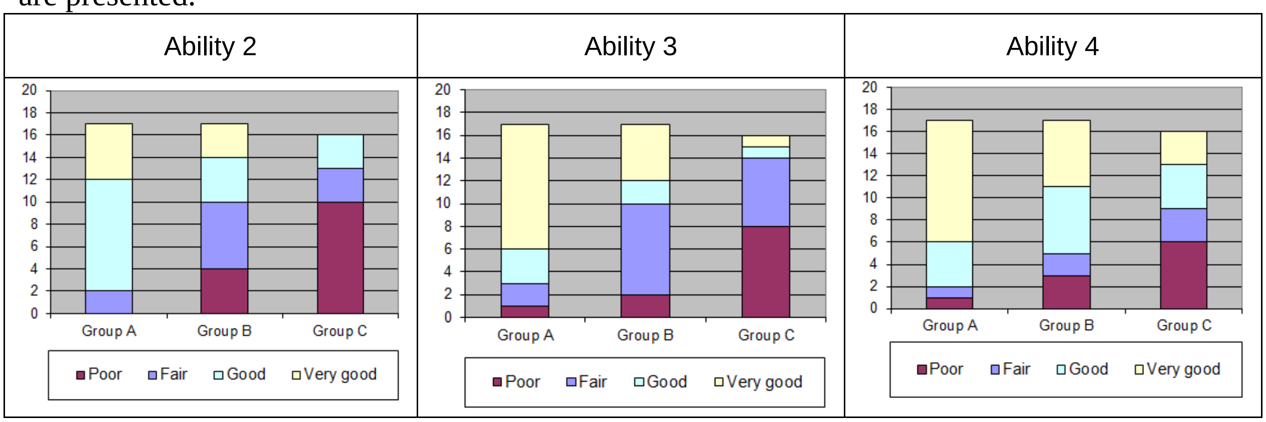


Figure 8. Performances of the three groups at the three "core" abilities related to inference

Figure 8 shows that in all the three abilities poor performances prevail in group C and viceversa good performances prevail in group A while medium achievers are always in between the two.

While looking at Figure 8 nevertheless we must consider that the three graphs should be regarded singularly and no direct comparison among the three graphs representing the three different abilities can be done.

The structure of the available data doesn’t allow us to directly compare the performances of the three groups of students in the different abilities: our data are, in fact, based on the calculation of the percentiles which varies in the different abilities (treated as independent) as a consequence of the different number of correct answers given by the sample population.

Despite this, if we look singularly at the considered reasoning abilities, we see that high achievers always perform better than the other two groups.

The emerging trend is the same for all the six considered abilities, despite reasonable differences can be found due to the intrinsic level of difficulty of each of them, as illustrated below.

Ability 5

As to the ability of managing uncertainty (Ability 5), Group C students show genuinely poor performances while high and medium achievers performances are comparable.

Ability 5, namely the ability to be able to establish whether the data available at a given moment of the game are sufficient to decide whether a certain guess is correct or not, clearly discriminates among the three groups: it appears to be very difficult for low achievers (Figure 9), so that only very few of them perform well. Both the other two groups, instead, appear to be more confident with the task.

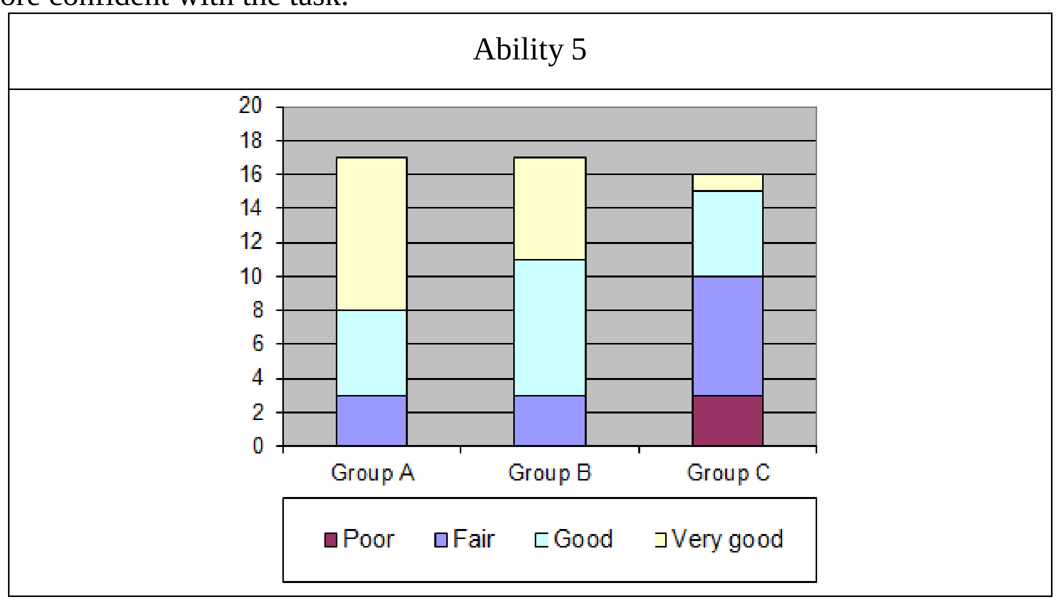


Figure 9. Performances of the three groups at the ability of managing uncertainty

Ability 6

As to the ability of operatively applying reasoning abilities (Ability 6), performances of students in Group A are higher with respect to those of students in the other two groups. Differences between group B and Group C are found as well, in favor of Group B.

Ability 6 implies to "operatively applying reasoning abilities", namely to be able to implement into the game the results of own reasoning (in the logic that actions should follow thoughts). Group A performance is far higher with respect to the one of the other two groups (Figure 10): this could allow arguing that students in this group are more able to “put into practice what they have learnt" and this attitude/ability could be responsible for their good achievement in curricular activities.

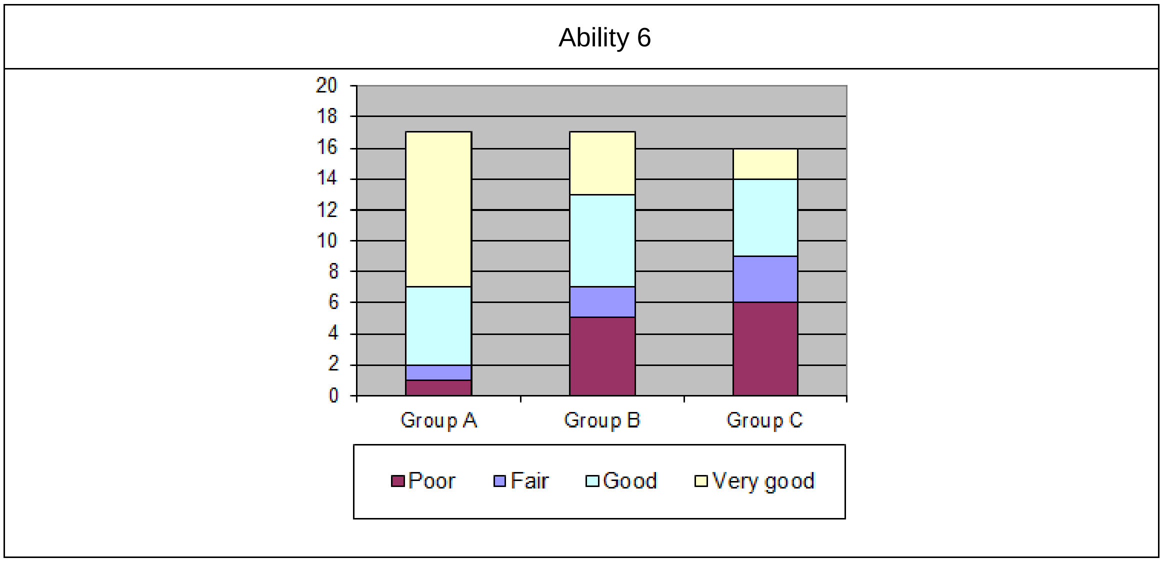


Figure 10. Performances of the three groups at the ability of operatively applying reasoning abilities

Attitudes

During the experiment, issues related to children's behavior such as engagement, attention and motivation were also investigated. This was done by means of made on-purpose monitoring sheets where the teachers and the members of the research group, while observing students at work, carefully recorded data on their attitudes considering a number of common specific indicators, to guarantee comparability.

Autonomy

The first attitude considered was autonomy, i.e. the capacity of children to find and enact solution strategies on their own.

As shown in Figure 11, it emerged that while students in the high and medium achievers groups were substantially autonomous most of those in the low achievers group frequently required help and advice, although only few of them were considered non-autonomous at all.

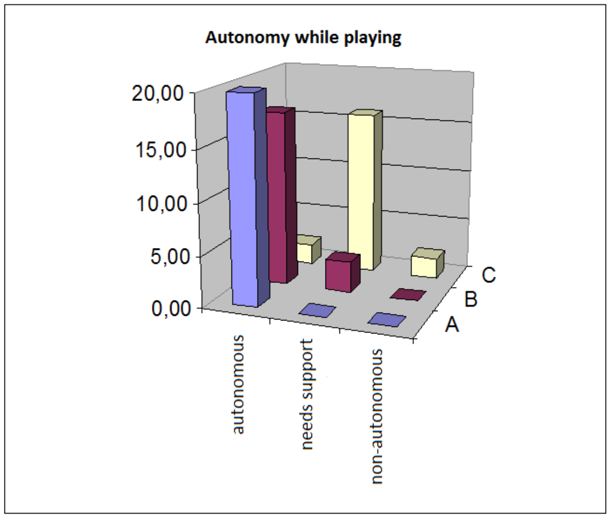


Figure 11. Level of autonomy shown by pupils in the three groups

Engagement and Motivation

The monitoring sheets where personal notes of the observers and answers to questions by the involved subjects were annotated showed that all pupils were fundamentally attentive and engaged in the task (Figure 12). Their level of motivation resulted to be quite high during the whole experiment; this was true also for a consistent number of low achievers, irrespective of their actual gaming ability and capacity to reach the solution.

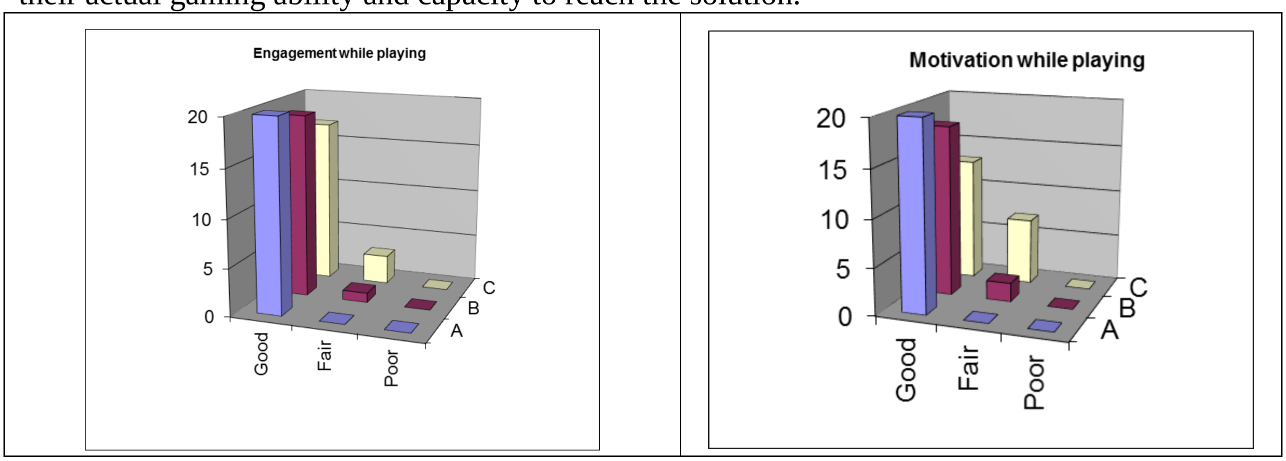


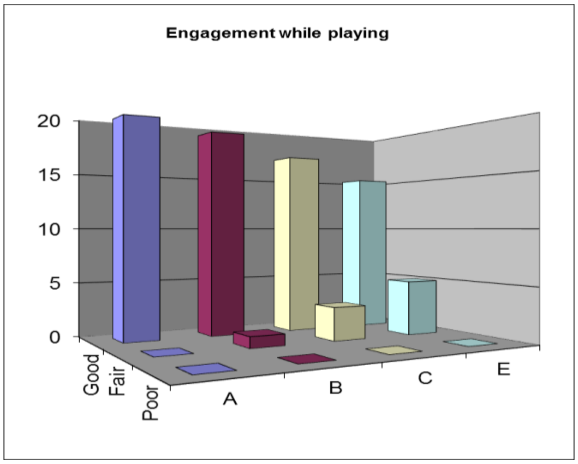
Figure12. Levels of engagement and motivation shown by pupils in the three groups

These data confirm that a considerable amount of children of the target age are attentive and engaged in the interaction with mind games, despite their level of achievement, even those that need adequate support by educators to reach the game solution**.**

The findings on students' attitudes towards gaming activities are confirmed by the results of the parallel investigation conducted on the sample of 20 pupils with certified learning disabilities from the Genoa school (Dagnino et al. 2013).

If we consider also this group (Group E) we see (Figure 13) that engagement and motivation while playing of these students is to some extent comparable with that of low achievers of the other considered sample (Group C). Of course, while reflecting on these data we need to take into account the fact that these students, during all the phases of the experiment, were individually monitored and assisted (i.e. they could count on the constant presence/assistance/advice of one person of the research team).

An interesting consideration regards the fact that motivation in Group E students appears to be higher with respect to those in group C; this is probably due to the fact that these students, being constantly assisted by adults, were less impressed by personal failures (Ott & Tavella, 2009)



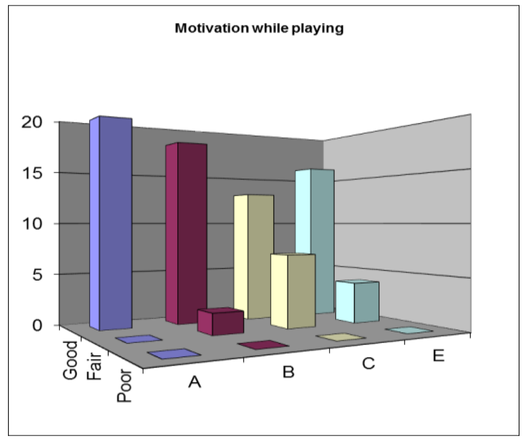


Fig.13. Level of engagement and motivation shown by pupils in the three groups plus a group of 20 students with severe learning disabilities

DISCUSSION

The final aim of the described experiment was to investigate whether digital mind games can be used successfully to elicit and support the development of those “transversal” reasoning abilities that affect global school achievement.

To this aim, evidence was found that:

- A substantial consistency exists between primary school students’ school achievement and the ability of playing digital mind games.
- The great majority of students, independently from their level of school performance, are basically very attentive and engaged in game-based learning tasks.

As a matter of fact, from the conducted experiment it emerged also that:

- The performances at games are scaled and reflect the results of high, medium and low achievers.
- The ability itself of recalling games rules is more present in high achievers and progressively at a lesser extent in the other groups of students.
- Inference tasks are well performed by high achievers but represent a sensible obstacle for low achievers (mainly when inferences need processing more than one datum).
- The ability of verifying the work done by also managing uncertainty and establishing whether the data available at a given moment of the game are sufficient to decide whether a certain guess is correct or not is peripheral for the group of low achievers.
- The ability to put into practice what learnt during exercises is almost a prerogative of high achievers.

- The level of autonomy in playing games is good for both high and medium achievers while low achievers need some external help.
- Digital games attract all students' attention and stimulate their engagement and motivation.

Since the experiment was based on games that do not require knowledge/competences specific to curricular school subjects (e.g. arithmetic, linguistic), the obtained results suggests that playing with mind games can profitably exercise transversal skills that are involved also in curricular tasks and activities (e.g. making inferences, verifying the work done, recalling rules, etc.).

Digital games are suitable tools to exercise such skills in that they are well accepted by students and able to stimulate their positive attitude towards learning.

The actual effectiveness of game-based training programs in the field of logical abilities is substantiated also by the findings of a previous research experience conducted by the authors (Bottino et al., 2007) that showed a positive impact of the gaming activity on both school performance and learning behavior.

The experiment, in fact, had evidenced that a group of students who had undergone a game-based reasoning and logical training with games for a long period (three school years) performed better at a national math test with respect to a control group. The teachers involved in the experiment had also reported a positive impact of the gaming activities on the general learning behavior of the students involved in the experiment.

Based on all these results, we could reasonably draw the conclusion that mind games could be adopted profitably in early educational programs targeting the development and the enhancement of "transversal" reasoning skills and that they may have, in turn, a positive impact on the students' global school achievement.

The experiment conducted with severe low achievers and the comparison of their levels of engagement and motivation with those of students with different levels of school achievement shows that they could also benefit of specific targeted, personalized interventions (Pozzi, 2009) based on a specific users' profiling (Felicia, 2009b) and a carefully planned use of mind games.

CONCLUSIONS

The results of the reported experience, together with previous findings in the field, support the idea that digital mind games can effectively be used to sustain logical and reasoning abilities in 8-10 years old primary school students and that this could influence global school achievement as well. The specific case of students with severe ascertained learning disabilities was also investigated and it emerged that, if properly assisted and tutored, also these students find such an exercise motivating and engaging and, if appropriately followed by teachers, can almost reach the level of performance of students who are low achievers but who have not ascertained disabilities. According with such finding, it seems possible to argue that also cognitive disabled students can benefit from activities with mind games and that their reasoning abilities can to some extent be enhanced.

The target population of the experiment, as said above were students in the age range from 8 to 10, nevertheless, the hypothesis (to be verified with further in-depth studies) can also be put forward that also children in different age groups could benefit from playing with mind games.

In the case of younger children (e.g. 6 years old students), for instance, a specific game-based training could help them to start their school career with the right foot. Moreover, mind games playing could be included among the activities of a remedial program for older students who have evidenced some learning difficulties.

Further studies in both these directions are in progress.

To conclude a set of general indications based on our experience can be given to support those teachers and educators interested in using digital mind games with their students. In particular, we see that there is a need for reflecting on the importance of:

- Making an accurate choice of the specific games to be adopted by carefully paying attention to the entailed abilities and to games usability.
- Choosing games that are relatively independent from specific prerequisites in curricular school subjects.
- Accurately planning the sequence of the mind game based exercises by tuning the progression of the difficulty level.
- Appropriately calibrate the level of assistance that teachers offer to each single student so as to trigger logical thinking and adequately support students' motivation and engagement.
- Consider that the use of mind games can prove useful if it is not sporadic and planned on a short term basis but if it is incorporated in activities that cover a medium/long term period of time (e.g. one hour a week for a 5/6 months).

It is worth underlying that, in general, the educational effectiveness of games in school activities is strictly linked to the way they are used and that the role of the teacher is crucial to this end. The teacher has to define the specific aim, context and modalities of games use, also including, if needed, specific customizations (e.g. setting difficulty levels, deciding on help available to students, configuring interface constraints).

REFERENCES

Bottino, R. M., Ott, M., Tavella, M., & Benigno, V. (2010). Can digital Mind Games be Used to Investigate Children's Reasoning Abilities?. In Meyer, B. (Ed.) *Proceedings of the 4th ECGBL Conference on Games Based Learning Copenhagen,* (pp. 31-39). Academic Conferences-Academic Publishing International, Reading, UK.

Bottino, R. M., Ott, M., & Benigno, V. (2009). Digital mind games: experience-based reflections on design and interface features supporting the development of reasoning skills. In Pivec, M (Ed.) *Proceedings of the 3rd European Conference on Game Based Learning (ECGBL),* (pp. 53-61). Academic Conferences-Academic Publishing International, Reading, UK.

Bottino, R. M., Ott, M., & Tavella, M. (2008). The impact of mind game playing on children's reasoning abilities: reflections from an experience. In *Proceedings of the 2nd European Conference on Game Based Learning (ECGBL),* (pp.51-57). Academic Conferences-Academic Publishing International, Reading, UK.

Bottino, R. M., Ferlino, L., Ott, M. & Tavella, M. (2007). Developing strategic and reasoning abilities with computer games at primary school level. *Computers & Education,* 49(4), 1272-1286.

Bottino, R.M. & Ott, M. (2006). Mind games, reasoning skills, and the primary school curriculum: hints from a field experiment. *Learning Media & Technology,* 31(4), 359-375.

Burke, R. J. & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A research paradigm whose time has come. *Educational Researcher*, 33(7), 14-26.

Burke, R. J., Onwuegbuzie, A. J. & Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, 1, 112-133.

Dagnino, F. M., Ballauri, M., Benigno, V., Caponetto, I. & Pesenti, E. (2013). Reasoning abilities in primary school: A pilot study on poor achievers vs normal achievers in computer game tasks. *Learning and Individual Differences,* 23, 213-217

De Freitas, S. & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated?. *Computers & Education*, 46, 249-264.

Djaouti, D., Alvarez, J., & Jessel, J. (2011). Classifying Serious Games: The G/P/S Model. In P. Felicia (Ed.), *Handbook of Research on Improving Learning and Motivation through Educational Games: Multidisciplinary Approaches,* (pp. 118-136). Hershey, PA: Information Science Reference. doi:10.4018/978-1-60960-495-0.ch006

Felicia, P. (2009). Digital games in schools: Handbook for teachers. European Schoolnet, Brussels, from http://hal.archives-ouvertes.fr/docs/00/69/75/99/PDF/FELICIA-2009.pdf.

Felicia, P. (2009). Modelling Players' Behaviours and Learning Strategies in Video Games. In Pivec, M (ed.) *Proceedings of the 3rd European Conference on game based learning (ECGBL),* (pp. 120-123). Academic Conferences-Academic Publishing International, Reading, UK.

Franco, C., Mañas, I., Cangas, A.J., & Gallego, J. (2011). Exploring the Effects of a Mindfulness Program for Students of Secondary School. *International Journal of Knowledge Society Research* (IJKSR), 2 (1), 14-28.

Herbert, J. (1970). Direct observation as a research technique. *Psychology in the Schools*, 7(2), 127-138.

Hong, J. C., Cheng, C. L., Hwang, M. Y., Lee, C. K. & Chang, H.Y. (2009). Assessing the educational values of digital games. *Journal of Computer Assisted Learning*, 25, 423-437.

Kebritchi, M., Hirumi, A. & Bai, H. (2010). The effects of modern mathematics computer games on mathematics achievement and class motivation. *Computers & Education*, 55(2), 427-443

Kirriemuir, J. & McFarlane, A. (2004). *Literature Review in Games and Learning*. (Report 8: Futurelab Series), from http://archive.futurelab.org.uk/resources/documents/lit_reviews/Games_Review.pdf

Martinovic, D.; Ezeife, C. I.; Whent, R.; Reed, J.; Burgess, G. H., Pomerleau, C. M.; Yang, Y. & Chaturvedi, R. (2013). Critic-proofing of the Cognitive Aspects of Simple Games. *Computers & Education.* Available online 9 November 2013 from DOI 10/1016/j.compedu.2013.10.017

Milovanović, M., Minović, M., Kovačević, I., Minović, J. & Starčević, D. (2009). Effectiveness of Game-Based Learning: Influence of Cognitive Style. In Lytras, M. D., Ordonez de Pablos, P., Damiani, E., Avison, D., Naeve, A. & Horner, D. G. (Eds.) *Best Practices for the Knowledge Society. Knowledge, Learning, Development and Technology for All*. Communications in Computer and Information, 49 (pp. 87-96). Science Springer, Heidelberg.

Ott, M. & Tavella, M. (2009). A contribution to the understanding of what makes young students genuinely engaged in computer-based learning tasks, *Procedia - Social and Behavioral Sciences*, Vol. 1. Issue 1 (pp 184-188). ISSN 1877-0428.

Pivec, M. (2007). Play and learn: potentials of game-based learning. *British Journal of Educational Technology*, 38, 387-393.

Pozzi, F. (2009). Supporting Group and Individual Processes in Web-Based Collaborative Learning. In Mourlas et al., (Eds.), *Cognitive and emotional processes in web-based education: integrating human factors and personalization*, IGI Global, USA, 396-413.

Prensky, M. (2001). *Digital game-based learning*. McGraw-Hill, New York.

Prensky, M. (2005). Educational Games Complexity Matters: Mini-games are Trivial - but “Complex” Games Are Not. *An important Way for Teachers, Parents and Others to Look At Educational Computer and Video Games*, Educational Technology, 45 (4), 1-15.

Robertson, D. & Miller, D. (2009). Learning gains from using games consoles in primary classrooms: a randomized controlled study. *Procedia Social and Behavioral Sciences*, 1(1), 1641-1644.

Rohde, T. E., Thompson, L. A. (2007). Predicting academic achievement with cognitive ability. *Intelligence*, 35(1), 83-92.

Sandford, R., Ulicsak, M., Facer, K. & Rudd, T. (2006). Teaching with Games. *Futurelab report*. from http://archive.futurelab.org.uk/projects/teaching-with-games. Last accessed 10/05/2013.