Science, Sport and Technology - a Contribution to Educational Challenges

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Abstract: Improve students' ability to link knowledge with real life practice, through enhancing children or teenagers' ability to think critically by way of making observations, posing questions, drawing up hypotheses, planning and carrying out investigations, analysing data and therefore improve their decision making is an educational challenge. Learning through sports can be effective for developing life skills because sport has a potential to contribute over a wide range and is a discipline that most children like. The constructions of real situations or "Problems" must achieve and incorporate certain aspects such as (a) encourage curiosity, (b) be perceived by students as relevant to their personal goals, (c) represent a motivated challenge, (d) stimulate group collaboration for older students, (e) technological equipment as a way of support, to motivate the learning process, and (f) demonstrate how simple scientific concepts can improve everyday activities. The aim of this paper is to present and evaluate the usefulness of the representative tasks created by a systematic integration of approaches (electronic and non-electronic devices) with interactive situations. Four tasks were applied to 140 children between 6-10 years old at elementary school level. The tasks were constructed considering the follow proposals: (1) promote the benefit of physical activity and (2) explore some science concepts using sport. To evaluate the process effectiveness, two groups were formed, group A was submitted to a more theoretical explanation of the concepts and group B was exposed to problem solving through sport situations. Data were analysed by using quantitative methods. Results show that when children participate in an active way they are more motivated, and the use of their own movement or body to resolve a problem (with electronic devices) contributes for knowledge acquisition by adapting their actions and looking for the best window of possibilities to solve the task situation. Further and longitudinal studies are recommended to consolidate the results.

Keywords: technology, sport, task design, skills acquisition

1. Introduction

The needs and demands of education in the modern dynamic world has become one of the greatest challenges we now face (Dewey1997a, b; Delacôte, 1998a, Fishman & McCarthy,1998). No longer is one teacher, one classroom, one desk and one textbook sufficient. We also know that it is not merely a question of resources, finances, material or technology, items which although important, will not in themselves solve the number one problem, which is how to supply a wider range of competences for students to be well prepared for a future which is indelibly shaped by uncertainty (Colwell &Kelly, 1999; Windschitl, 2000; Wilson & Corbett, 20001).

ELearning implementation enables the learner to explore, discover, and construct subject matters and communicate problems and ideas with other community members, being a powerful tool to achieve goals if teachers have suitable strategies and pedagogies for an effective implementation (Kahiigi, Ekenberg, Hansson, Tusubira & Danielson, 2008; Garrison, Anderson & Archer, 2000).

When we observe the educative landscape at the macro level, we can verify (OECD, 2002) that for some, we are in (a) an Information Society, while for others, in (b) a Knowledge Society, and for yet others, in (c) a Learning Society. However, as we concentrate on supplying a wider range of competences, it is absolutely crucial to analyse the consequences and implications of being in these "societies", since:

(a). to be in the Information Society is to run the risk that the information received is just as likely to be disinformation, because the quantity of data available nowadays (which may or may not be useful, correct or incorrect, or may have a positive or negative impact), whether in terms of quantity or speed, is only worthwhile if it allows the user to develop the necessary competences that permit the user to

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select from the available information, that which will contribute to a better understanding, solve problems and learn new things;

(b). to be in the Knowledge Society implies understanding the difference between knowledge as an unrelated set of facts and knowledge as an integrated phenomenon and also understanding if that which is valued most, is or is not how the individuals obtained that knowledge, the things they picked up on the way to getting that knowledge and what motivated the learning of that knowledge;

(c). to be in the Learning Society where students have teachers and other resources at their disposal to achieve their goals and objectives, implies having the capacity to prepare competent individuals who will want and know how to implement projects, because, according to the OECD, a society that demands an *ASK* programme (*attitudes, skills, knowledge*).

If we zoom inside this educational landscape at the micro level, we need to have the capacity to develop the necessary competences which consider learning to be largely about modifying individual representations rather than the result of a process of "stacking" information/knowledge. A representation is not just the outcome i.e. that which the student verbalizes, writes, draws, plays or does, but the underlying neuronal structure from which these actions originate (Giordan, 1998).

Guided by the above mentioned macro and micro perspectives, we propose in this paper to design an experimental approach to work on an example of this wider range of competencies, Problem-Solving Skills, "i.e. the capacity of students to understand problems situated in novel and cross-curricular settings, to identify relevant information or constraints, to represent possible alternatives or solution paths, to develop solution strategies, and to solve problems and communicate the solutions" (OECD, 2004), showing both the theoretical foundations that need to be considered, and the active principles that we turn to for operational purposes.

From a theoretical point of view, the following are to be considered:

Learning should be centred on the student

In order to construct an interactive environment as a tool to assist students in their reasoning and finding the possible solutions, they become active participants in the learning process. However even when centred on the student, this process needs to be structured and facilitated by the teacher and/or team work, in order to permit the realization of concrete situations, where the activities being promoted will allow the participants to manipulate, experiment and interpret phenomena according to different functional perspectives and previously defined objectives (Dewey1986, 1997; OECD, 2002, 2004, 2007);

The development of a process to stimulate curiosity based on problem situations

The capacity to raise pertinent questions and attempt to critically interpret the available indicators in order to find the best possible solutions depends on a change of attitude and the profound transformation of the individual, while demanding systematic and sustainable work. Clearly this work rests on the capacity of the team work to make use of conceptual and material instruments, while trying to establish a ludic and critical spirit in the search for organisation and mastering of knowledge (Richard, 1999; OECD, 2002).

The development of a technological and scientific reasoning

The problem situations put forward by the team work should stimulate curiosity and the capacity to be critical which in turn will lead to the development and training of a scientific reasoning that will a) raise and equate hypotheses for resolution; b) use information, data, and available documentation to allow reflection, and represent systems for alternative resolutions; c) select strategies for resolution; d) present results and reasons which can be debated; d) present new questions and doubts which appear as the process runs its course (Folder, 1993, Alper, 1994; Delacôte, 1998b; Richard, 1999 ; Crawford, Saul, Mathews & Makinster, 2005; Reimann & Jacobson, 2010).

On the bases of the above mentioned theoretical foundations, our experimental situation (Delisle, 1997) made use of the following active principles(:

Student-centred learning

Our interactive environment is done through real life situations which, depending on the students' level, will allow them to create strategies to solve the problems. What is desired here is that when students are presented with a series of problems, they will solve them by making the best choice from a window of possibilities. To accomplish this we used various instruments, including computer graphics, animations, heart rate monitors, videos and smart boards.

Developing a process of curiosity based on problem situations.

Sport is used as the catalysing agent for the motivation and interest of the participants: the use of games to present strategic problems guided by objectives and rules; the definition of competitive situations within a certain range of challenge; the elaboration of a points system that will permit the verification of results and the fulfilment of partial objectives, a system for rotating through different goals and or tasks, allows the acknowledgement of individual limits and identify the strong and weak points of each element leading to the improvement of the team work while at the same time showing how different individual competences will affect the capacity of the team.

The development of a technological and scientific reasoning.

The tasks were conceived for promoting the benefit of physical activity and to explore some science concepts. All situations considerer different resolutions and strategies to reach the goal and are accompanied with video and smart board information. This information was given a) at the beginning of the task, so we can present the problem, the concept and the aiming goal, b) during the task for helping the possible problem resolution and c) at the end in order to make an overview of the global task and provoking discussion about the concepts and its functionality.

In this article we chose the concepts of heart rate (HR) and energetic balance (EB). Physical activity and health are recognized as an important means to helping children and youths attain a healthy emotional, social and physical well being (Strong, Malina, Bumkie, Daniels, Dishman, Gutin, Hergenroeder, Must, Nixo, Pivanirk, Rowland, Trost & Trudeau, 2005). In fact, encouraging the physical activity in children and adolescents is often viewed as an effective health promotion and a disease prevention strategy for the adult population (Thompson, Humbert & Mirwald, 2003). In last decades numerous studies reported a significant decline in physical activity levels on children and adolescents. Different factors contribute for this physical inactive behaviour, typical of the actual lifestyle. The new technologies, sedentary player games, and the unsafe and inaccessible places to practice physical activity are some examples that do not support the regular physical activity prevalent in childhood and youth (Larsen, McMurray & Popkin 2000).

To promote a lifetime inclusion of physical activity in children and adolescents, several aspects should be considered for a globally agreed strategy, as school and physical education, community and sports local programs, and family support (Thompson *et al.*, 2003). The school has an important role in this field, because it can promote the practice of diverse physical activities and experiences, but it can also promote the physical activity as an instrument of learning and social and physical development (Folder, 1993; Alper, 1994, Laursen, Liston, Thiry & Graf, 2007).

2. Methodology

In order to investigate the effectiveness of the active principles defined in micro level (points 1, 2 and 3), we create interactive real life tasks by integrating the concepts of Energetic Balance (EB) and Heart Rate (HR) with different eLearning tools (Kahiigi et al, 2008), such as video camera, heart rate monitor and smart board.

2.1 Participants

140 children (age between 6 to 10 years) from elementary school were selected and divided randomly in two groups, where group A, n= 73 and group B, n=67. Group A were exposed to a more theoretical explanation for heart rate (HR) concept but made the practical situations for energetic balance (EB) whereas group B made the opposite approach.

2.2 Statistical analysis

Descriptive analyze and independent samples Mann-Whitney U test was used to compare groups. A *p* value of 0.05 or less was considered as significant. All p values are two-tailed. The data were analyzed using the software Statistical Package for the Social Sciences (PASW 18 for Windows; SPPS).

2.3 Experimental design

All tasks (theoretical and practical) started with a question based on simple real things and built in a way that children were conducted to think, to encourage curiosity, to motivate solving the problem and the answer could only be achieved if they played the game. The introductory purpose for each task gives the clue to the concept that will be introduced. The purpose is complete enough to present the goal, but does not give away the “mystery” of the results. There is an element of surprise in each tasks and guaranteed fun and competition.

For the EB the questions were “can we have the same energy from all types of food?” and “can we eat without being fat?”. To the HR concept the questions were “How does our blood circulate?” and “how can we increase our heart rate?”

At the end of each task, a test for each concept was applied, equal for both tasks (theoretical and practical). More than evaluating the capacity of children to define the concepts *per si*, we intend to assess the capacity of the learning tasks proposed to develop the aspects presented on micro level (points 1,2 and 3).

For EB concept the test has a total of 30 questions, divided in 3 main categories, where Q1 and Q2 correspond to the capacity of the children to define the concept (with a total of 12 questions, 6 for Q1 and 6 for Q2), Q3 and Q4 represents the capacity of the children to choose and combine different possibilities (a total of 10 questions, 6 for Q3 and 4 for Q4) and Q5 and Q6 the capacity that they have to integrate different aspects of the learning knowledge to give the answer (a total of 8 questions, 5 for Q5 and 4 for Q6).

For HR concept the test has a total of 32 questions. The same structure was used to define the categories, where Q1 and Q2 has a total of 11 questions, 5 for Q1 and 6 for Q2, Q3 and Q4 have a total of 12 questions, 6 for Q3 and 6 for Q4 and Q5, Q6 and Q7 have a total of 9 questions, 5 for Q5, 2 for Q6 and 2 for Q7.

2.4 Theoretical tasks

The theoretical task (both for EB and HR) started with a question about the concept definitions, their significance, how they can be quantified and altered. Visual and experimental support instrumentation was used to facilitate the concept understanding. Questions were presented in other to create interaction between children and research team for establishing the comprehension level of the concepts by them. In consequence, the research team was able to apply different types of games.

For the HR concept the questions were “How does our blood circulate?” and “how can we increase our heart rate?”. The tasks were created in other to develop the perception of the heart rate concept, monitoring with polares (HR instrument).

For the concept of EB the introductory questions were “Can we have the same energy from all types of food?” and “Can we eat without being fat?”. The tasks aimed to provoke the sensibility of the concepts of calorie and fat cell. During the task the children had video segments and smart board information, for instance, they calculated how much energy was introduced to the organism by some food (visible on video) and how much was used (for example, in relation to sports activity).

Research team used those tasks not only to diagnose the comprehension level but also to control the children’s evolution.

2.5 Practical tasks

With the intention of establishing the level of children’s knowledge, in the beginning of the task, they were questioned about day-to-day things where the concepts (HR and EB) could be applied. At the end of each task, they were once more questioned not only about the definition of the concept but also about the underlying aspects of the concepts and its functionality, such as "What did you do to reach your objective?", "How did you do it?", "Why did you do this?".

For the concept of Heart Rate (HR) the main question was "How does our blood circulate?" and "how can we increase our heart rate?". Children show that they have the perception that only physical effort can increase HR. Various type of games were used to show different levels of HR increase and the recovery time needed to decrease those different intensity levels. The children had their own HR monitor as a feedback for their performance.

Since HR variations also depend of other factors, two tasks were set up to show how emotions can influence HR:

Heart rate task 1(HR1) - "Let's Dance", the aim is to show that stress resulting from the relationship between two people could increase HR. Research team manipulated territorial behavioral space and children were paired up, male and female. Each child had a HR monitor beeper according to the maximum and minimum levels set by the supervisor. The goal was to dance without passing the HR maximum limit. If this happens they had different possibilities to decrease the HR value and return to the game. The points were awarded based on their capacity to control HR. At the end, by using video images, we could show them how stress led to an increase in HR.

Heart rate task 2 (HR2) - "Treasure hunting", the goal is to show that factors like blindfolded and communications between the pair provoke the HR changes. The children were put in pairs with the objective of seeing which pair could find the largest number of balls (the treasure). In each pair, one child was blindfolded and could only move by following his partner's verbal instructions. The children won the game if they could catch more balls, without passing the HR maximum limit.

More in both HR situations the player had different possibilities, by managing their own action and /or the opponent team, to increase or decrease HR values.

For the concept of Energetic Balance, the main questions were "Can we have the same energy from all types of food?" and "Can we eat without being fat?". Two tasks were set up:

Energetic Balance situation 1 (EB1) - "Eating without being fat". The aim was to show that calories are fundamental in supplying energy to the organism; if they are not completely used up they contribute to weight increase. Each pair received a card with a food type. First they had to identify the quantity of calories of this food type (using video information) and then define the effort that they have to make to burn the excess calories, in proportion to the amount of effort needed to complete the task. They were then asked to complete a circuit with more or less difficulties (by the type of obstacles, travel distance), depending on the number of calories per effort.

*Energetic Balance situation 2 (EB2)***-** "Looking for the good fat cell". The aim was to show that there are various types of fat cells (good and bad) and their consequent implications on the functioning of the organism. To transmit this knowledge researches create a circuit that combine speed, travel distance, balance and skill accuracy. To transmit the notion of bad fat cell they perform the circuit was mobility was decreased by adding weight in child limbs and by using uncomfortable clothes. For the notion of good cells they played normally without any constrains. The games began with each pair receiving a card with a food type and then perform the circuit.

3. Results and discussion

Heart Rate Tasks

Group B who perform practical situations present more correct answers than group A. Table 1 show the significative difference for both groups and the respectively *p* value when applying Mann-Whitney U test for $p<0.05$.

In questions Q1 and Q2 (Figure 1 and 2) even with significative difference between groups for 2b(83% for PG and 54% for TG), the response tendency was the same (correct) but not in 2e (21% for PG and 50% for TG). One possible explanation is that 2e spotlighted on questioning the normal values of Hr for a healthy grownup where 2b focus on using equipment to measure HR. Further, it is possible to observe that both groups give wrong answers when testing their concept knowledge about the phenomenon (Q1). One reason for this result can be the duration of the class thirty minutes plus the test, the age group in relation to the concept abstraction. In practical situations the children were so excited with the tasks environment that had difficulty to concentrate in the beginning of the class.

Table 1: p value for the answers in questions groups, when comparing PG Group B and TG Group A, $p<0.05$ Mann-Whitney U test

Question Nº	p value
2b	.015
2e	.009
3a	.025
3f	.011
4b	.008
4f	.037
6b	.043

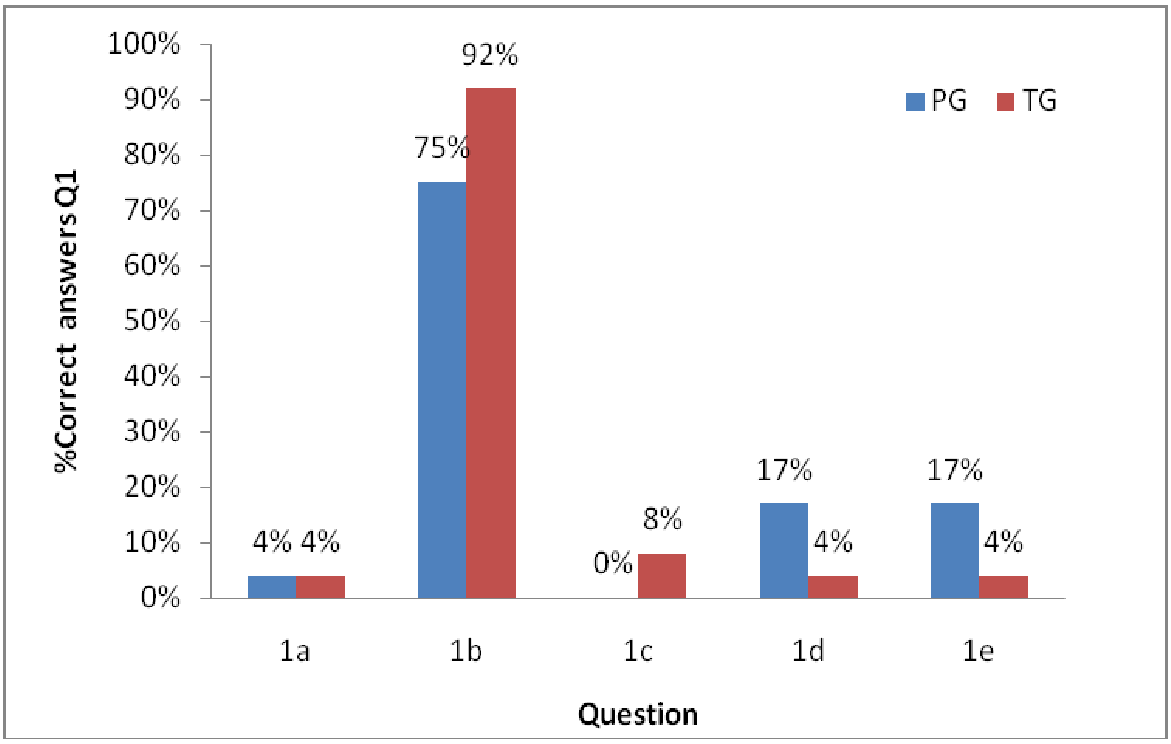

Figure 1: Percentage (%) of correct answers in Q1 for TG and PG in HR tasks.

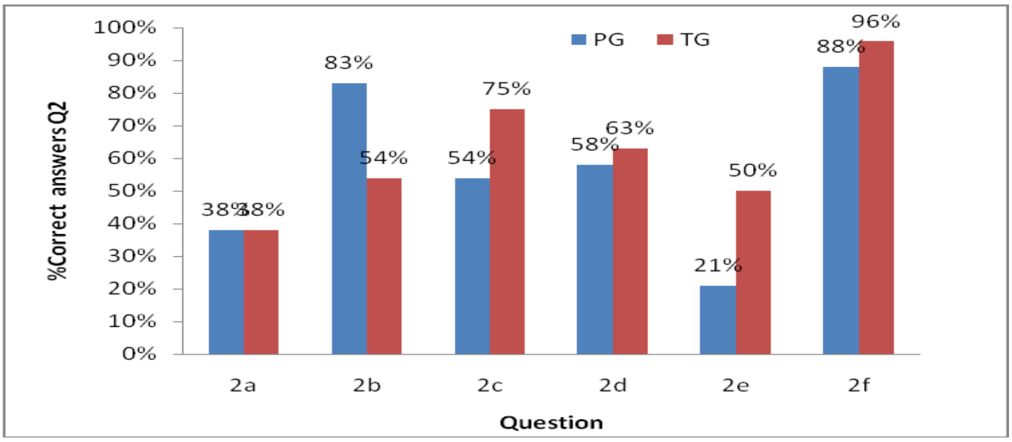

Figure 2: Percentage (%) of correct answers in Q2 for TG and PG in HR tasks.

Figure 3 and 4 show the quality of the answers.

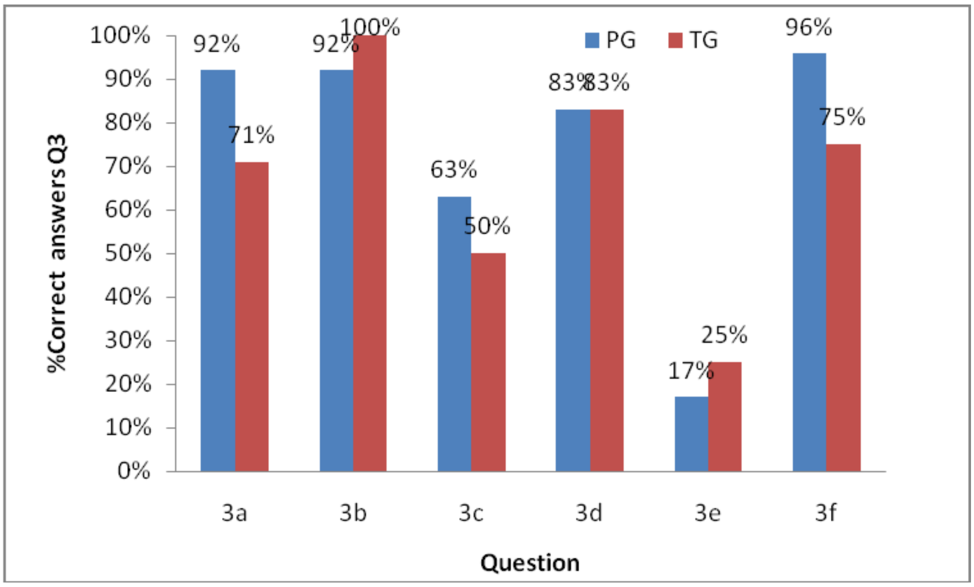

Figure 3: Percentage (%) of correct answers in Q3 for TG and PG in HR tasks.

Although these questions present more variation between groups, the tendency of the answer is the same so the high values of the correct ones.

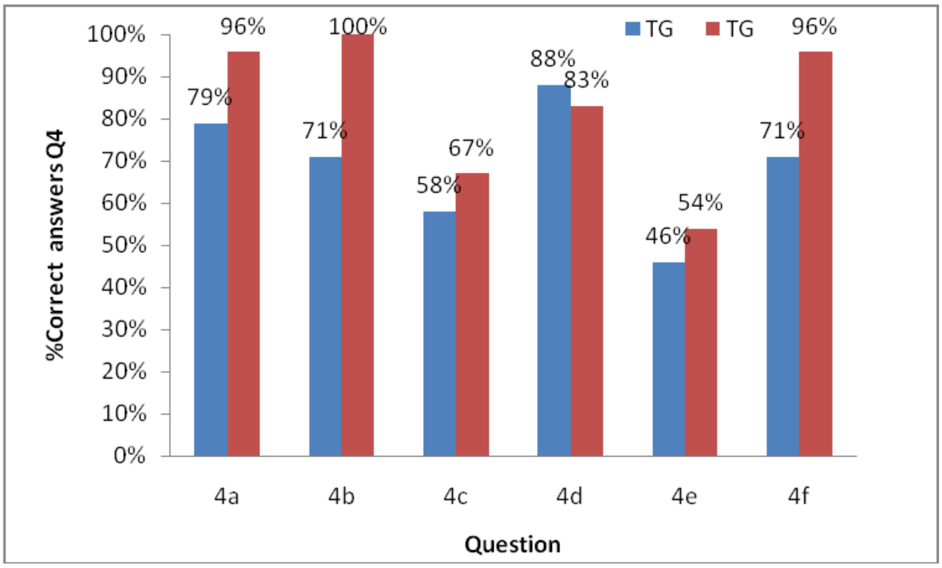

Figure 4: Percentage (%) of correct answers in Q4 for TG and PG in HR tasks.

For wrong answers the values are similar in both groups, therefore no significative difference was observed when the children respond to question that they have to choose and combine different possibilities.

The same tendency is present for Q5, Q6 and Q7 only differing on the number of correct answers (table 2).The children were able to correlate different information (questions 6 and 7) independent of the way the knowledge where transmitted. Nevertheless in both tasks the teacher had the same conceptual strategies.

Table 2: Percentage (%) of correct answers in Q5, Q6 and Q7 for TG (A) and PG (B) in HR tasks

Group	Question 5 (Q5)					Question 6(Q 6)		Question 7(Q 7)	
	5a	5b	5c	5d	5e	6.1	6.2	7.1	7.2
PG	79	83	79	75	38	96	83	96	92
TG	71	88	71	79	29	96	96	96	96

Even with bad results in Q1, e.g., defining the concept, the children were able to correlate and choose the best answer when doing the comprehension question, according to the results showed in Table 3 and 4. These results strengthen the hands-on pedagogical process (and because even in theoretical situations they had some experience by using e learning approach) and the problem based learning (Dochy, Segers, Van den Bossche & Gijbels, 2003; Wilson & Corbett, 2001).

Energetic Balance Tasks

Only for one question in group Q1 and Q6 there were significative difference, p=.003 and p =.001 respectively for p<0.05 Mann-Whitney U test.

The results show that the percentage of correct answer are similarly (figure 5 and 6) with in groups (TG and PG) for the more memory questions.

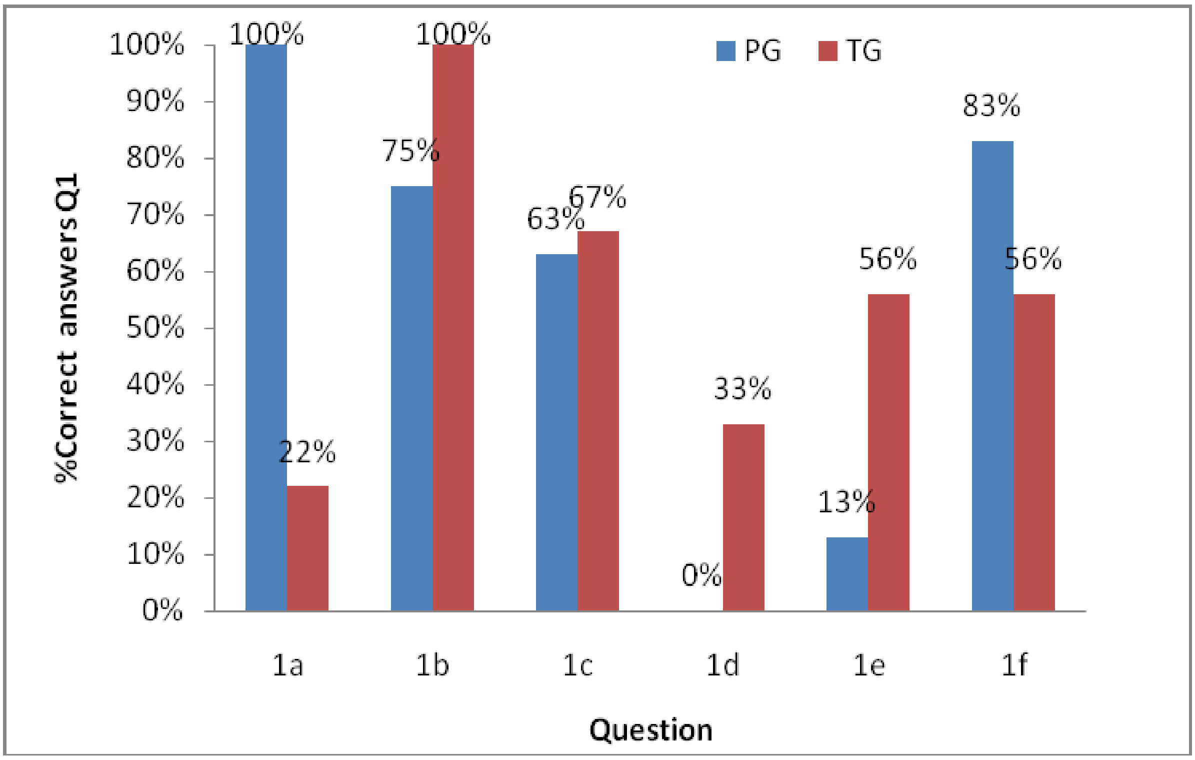

Figure 5: Percentage (%) of correct answers between TG(B) and PG(A) in Q1 for EB tasks

Even when the children give the wrong answer (1d) both groups present a very low percentage. Therefore it is possible to see the same tendency of answer (correct or wrong) between groups.

In respect to those questions that involved the selection of more than one possibility Q3 and Q4 there were no difference between groups. Question 3a (figure 7) and 3 e present a significative difference between groups with a divergent tendency on their answers.

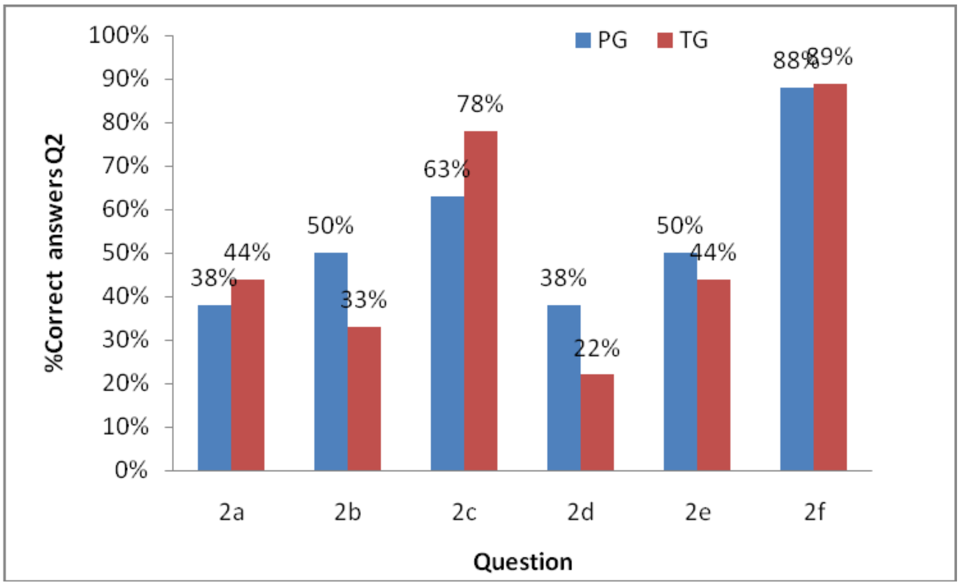

Figure 6: Percentage (%) of correct answers between TG(B) and PG(A) in Q2 for EB tasks

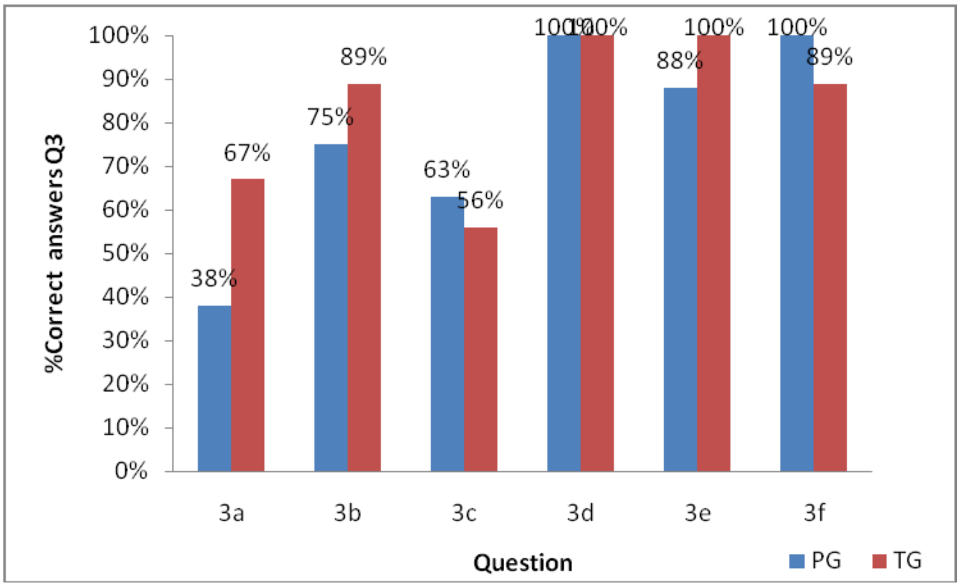

Figure 7: Percentage (%) of correct answers between TG(B) and PG(A) in Q3 for EB tasks

For the last questions groups (Q5 and Q6), despite only one question showing significative difference between groups, in table 7 it is possible to see that in all Q6 there is a great discrepancy in the answer given by the children. For TG with the exception of 5.3 and 5.5 (where they show that 11% and 33% give partially correct answer) wrong answers were given in this category. The PG children were able to provide correct answers whenever they had to make a relationship of the knowledge learned.

Table 3: Percentage (%) of correct answers between TG(B) and PG(A) in Q5 and Q6 for EB tasks

Group	Question Group 5 [Q5]					Question Group 6 [Q6]		
	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3
PG	75	88	63	88	63	100	100	100
TG	67	89	89	100	67	33	11	33

For a total of 62 questions only nine of them present significative difference between Practical (PG) and Theoretical (TG) groups (7 in 32 for HR and 2 in 30 for BI). These difference were in all questions groups (Q1 to Q7) but with more relevance in the group that had practical situations. Data presented in this paper is in agreement with Barrows (2004), OECD (2004) and Savin-Baden (2003), Laursen, et. al (2007) that children will benefit when exposed to a learning process constructed with the premises on developing the ability to make decisions and solve problems, and when exposed to several bodies of knowledge in a real life context. Because most of the situations presented in research create the task using one kind of knowledge, more studies with the same framework behind the task constructions are needed, in other to support our results.

4. Conclusion and future works

The findings obtained from this study are in agreement with Windschitl (2002) that learning would be optimized if students were involved in real life and meaningful problem-based activities. Also the results show that when children were faced by practical situations they develop the capacity to understand different constrains, and adapt their actions looking for the best window of possibilities to solve the problem, since they score more correct answers that those children exposed just too theoretical situations. We can verify that the use of e learning methods integrated within the learning process, if constructed by the guide premises (macro and micro level) considering the realness and the relatedness of the problem to the children's everyday experiences, can create a learning intention (Laursen, et al., 2007; Reimann & Jacobson, 2010). Participating in sport activity in an intentional way can develop life skills (Danish & Nellen, 1997, Goudas, Danish & Theodorakis, 2005), i.e. skills that are required to deal with the demands and challenges of everyday life. They can be not only physical (e.g., taking the right posture), but behavioral (e.g., communicating effectively), cognitive (e.g., making effective decisions). Nevertheless more studies are required, with the same conceptual structure, for developing new tasks with other concepts, or the same concepts with more variability and versatility of games and eLearning tools, increasing the integration of areas of knowledge and research teams. These new tasks should be applied to different ages and social contexts. Also, it is important to develop new assessment approaches and tools in order to control the reasoning process we present at micro level (1, 2 and 3). Longitudinal studies are also recommended to consolidate the results.The proposed tasks contribute to the development of the new educational challenge, showing how it can be possible to learn not only basic knowledge but also develop others skills and train the capacity to make decisions and solve problems in a motivating environment. Another conclusion from this study is that technology support and eLearning processes can be a powerful tool for learning when integrated within a conceptual framework that considers the development of Problem-Solving Skills, the ability to think critically and therefore improve decision making. In this case technology will naturally be included. So creating tasks that integrate different kind of knowledge, technology and in a same way are pleasure for does who participate, benefits the educational process and facilities the teacher action.

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