TWO BATTLES… TWO VICTORIES: HOW TO LEARN PROBABILITIES THROUGH A FAMILIAR GAME

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The beginning of the school year is a crucial time for grasping students' interest and attention regarding class work. This research took place in two 9th grade classes (n=38 students) from two different schools and realities. The task, which was the same in both cases, was the first of the school year. This task also marked the beginning of a new working methodology: collaborative work. Students played the Warship game in order to learn certain concepts related to the probability of an event. The game was followed by some questions about it, connecting intuitive and formal notions. Students were deeply engaged in the task because they love to play games. This way of beginning the school year was very stimulating for them. They felt comfortable learning Mathematics. We also observed that students did not reject the task and they did not experience any difficulty in these mathematical contents.

INTRODUCTION AND THEORETICAL BACKGROUND

In everyday life we can find multiple examples of the use of Statistics. The media are one of the main users of Statistics in newspapers, magazines, television, and also in the web. We can say that Statistics is familiar to almost everyone in many countries of the world. Nevertheless, if we focus on school, we should recognize that sometimes Statistics is not appreciated by all students, namely probability contents. Thus, it is important to reflect about this situation, trying to implement practices that allow students to be engaged in statistical tasks, namely in compulsory education (César, in press; Cobb and McClain, in press).

Gal and Ginsburg (1994) underline an important aspect: They consider that some non-cognitive elements, such as negative attitudes and beliefs towards Statistics, "can impede learning of Statistics, or hinder the extent to which students will develop useful statistical intuitions and apply what they have learned outside the classroom" (p. 1). It is important to promote learning experiences that are appealing, facilitating students' engagement, beginning by using their intuition and their ideas, and working through these in order to achieve formalization (Abrantes, Serrazina, and Oliveira, 1999). According to Gal, Ginsburg and Schau (1997) teachers should prepare an emotional and cognitive atmosphere where students feel safe, comfortable, believing in their abilities. A place where students "are motivated to struggle with and keep working on tasks or problems which may require extended investment of energy" (p. 2).

Teachers are key elements in classroom practices. They decide much of what is done, or not done, and they have a big role establishing the didactic contract that shapes the classroom culture (César, 2003, in press). Schulman (1987) refers that "teaching is, above all, understanding" (p. 14). But in order to achieve students' knowledge appropriation, teachers must also know and respect students' interests, expectations, their needs, and cultures. This could allow teachers to develop tasks that suit students' characteristics and culture (Bishop, 1988; Carraher, Carraher, and Schliemann, 1989; César, in press), promoting learning experiences which are significant to them. Thus, the nature of tasks is a fundamental aspect (César, 2003, in press; César, Oliveira, and Teles, 2004; Teles and César, 2005). Tasks can facilitate knowledge appropriation and the mobilisation of competencies, contributing to make the learning process more or less meaningful (César *et al*., 2004). Doise and Mugny (1981) underline that the social marking of tasks is an essential element in order to allow students to create bridges between their daily/previous knowledge, and the academic knowledge they must appropriate. Beginning a school year and a new content through a game is a way to help students create those bridges.

Teachers should assume their role as mediators and facilitators of the learning process (Vygotsky, 1978). Some authors have focused on the contribution of collaborative work to promote knowledge appropriation, and the mobilisation and development of competencies (Carvalho and César, 2001, 2002; César, 2003, in press; Perret-Clermont, Pontecorvo, Resnick, Zittoun, and Burge, 2004). Dyad and group work implemented in classrooms gives students the

opportunity to discuss with a colleague, conjecturing, testing their conjectures, arguing, explaining their solving strategies to their peers. And this is an advantage in Statistics learning.

In a more general context, D'Ambrosio (2005) stated that Education, namely Mathematics Education, should be contextualised. Also Batanero and Godino (2001) consider that "in Statistics we can develop small investigations or projects which put learning in context" (p. 15). In probabilities, playing a familiar game in order to appropriate knowledge is also a way of contextualization, which has proved to be a very effective one.

METHOD AND RESULTS

This study is part of the project *Interaction and Knowledge*, whose main goal is to study and promote social interactions, namely peer interactions, in classrooms. It has two levels: level 1 - micro-analytical, with quasi experimental studies; and level 2 - action-research, implementing dyad and group work during at least one school year. The results we are presenting and discussing come from level 2. The task was proposed to 38 students (9^{th} grade, 14/15 years old) working collaboratively for the first time. These students were from two different classes and schools, in two consecutive school years: 22 from a mainstream school; and 16 from a Dance school, with a completely different school culture (Teles and César, 2005). In both schools several students rejected Mathematics quite strongly. Thus, the same task was proposed in order to facilitate students' engagement in mathematical tasks, as well as their knowledge appropriation in probabilities. In both cases, this task was presented at the beginning of the school year, to introduce the chapter of Statistics and Probabilities, and to promote the beginning of the new working methodology: collaborative work. For data collection we used participant observation, students' protocols, and interviews. This task was divided into two parts: in the first one, each dyad had to play the Warship game; and, in the second, students answered to questions relating the game to the notion of probability of an event. The game was used to connect intuitive and more formal notions related to the concept of probability.

The beginning of the school year constitutes an important period to motivate students. One of students' usual hobbies is to play games. Thus, the choice of starting the chapter of Statistics and Probabilities through a game and its implicit mathematical content was a way of having a first activity with social marking which could facilitate students' meaning attribution to this mathematical task (Doise and Mugny, 1981). Talking with students, we realised that most of them were familiar with the Warship game. This made us decide to choose it as a starting point for promoting students' academic positive self-esteem, allowing many of them to participate in this mathematical activity, and to reconstruct their social representation of this subject. Ricardo emphasised this aspect by accounting that "It is quite nice. I mean, we understand things better and we memorize them more easily. (...) First, one needs good basic concepts. But then, a game can make all the difference." (Ricardo's interview)

This was the first time these students were working collaboratively, in both classes participating in this research. The game was a very good opportunity to promote students' discussion and interaction with their peers. This also constitutes an opportunity to work on students' Zone of Proximal Development – ZPD, constructing their intersubjectivity as they had to negotiate meanings in order to communicate (César, 2003; Vygotsky, 1978). Students appreciated collaborative work, as Elsa's, Salvador's and Fernanda's voices illuminate: "It is better because we are both thinking and... if one of the two doesn't know how to go on, the other one may have an idea" (Elsa, interview); "Because two heads think better than one." (Salvador, interview); "Because together (in peers) we can solve problems, explain our ideas and understand better." (Fernanda, interview)

It is interesting to analyze the way students describe their first thoughts about this mathematical task. As Ricardo stated: "At the beginning of the school year, when the teacher began bringing games, most of my colleagues told me: «Well, this year we aren't going to learn a thing... with games like this!»". But as time went by, it proved to be just the opposite and students changed their mind, as Ricardo also states: "(…) but afterwards, when we really began to solve tasks I realized... Well... the truth is that I had never expressed my opinion and I only thought it would be better, it was something like... original and that was going to be better... and now even my colleagues say that it's quite different from last year. Much better and many of us get higher

marks (...) and last year they were never able to do that. This year they're able to learn more because of the games". (Ricardo, interview)

For these students in these two different schools, beginning the school year by playing a game in a Mathematics class made the difference because they never thought it would be possible. Carolina's account illuminated students' traditional social representation about Mathematics and Mathematics learning: "I thought that learning Mathematics was only with books, exercise-books, calculators and things like that" (Carolina, interview). But it also made us understand that many students never experience diverse learning practices and tasks as recommended in policy documents (Abrantes *et al*., 1999). And this is one of the explanations for the high percentages of underachievement and rejection of Mathematics among children and teenagers, even during compulsory education.

In these classes, students played this familiar game during some minutes. Each student had to play it three times, and then answer the questions about this game and the probabilistic notions related to it. In order to make students work together, discussing their ideas, organising them to construct negotiated answers, we only gave each dyad a sheet with the questions. This feature made them engage quicker in the new didactic contract, beginning to co-construct their knowledge, and to develop their competencies.

For example, students should discuss the way they reached the enemy's boats. And they explained: "In the beginning, yes [it was by chance]. But after that we reached some boats, and we elaborated an attack strategy." (Cláudia and Salvador, class work). They also needed to answer in which boat they preferred to stay in order to be safer. And students did not have any difficulty in answering and justifying their position. As we can illustrate by Cláudia's and Duarte's written answer, students used very interesting arguments, stating other reasons beyond the number of small squares of each boat: "If we were sailors, we'd like to be in a submarine because they're fast, it's difficult to reach and see them, and also because we can see everything under and above them. We wouldn't like to be in an aircraft-carrier because it's big, slow and is in free air and there is more probability of being shot." This illuminates the difference between a pure probabilistic task/answer, and the connection that can be established with real life knowledge, including common sense, which is also an interesting theme to be explored.

At the end of the task students were asked about which was the safest place in order to stay alive: water or a boat. Students needed to discuss their opinions, deciding what they should answer. All students concluded that it was safer to be in a boat because "there are 75 small squares of water and 25 with boats. There is a higher probability to hit the water", as Carolina and Tiago wrote. This task ended with a classification of the experience they had done. Students replied that it was an unpredictable experience in that it depended on luck. After dyad work there was a general discussion in order to organise and formalise the discussed notions. The teacher helped students improve their mathematical language (e.g., arbitrary experiences replaced experiences on the sole basis of luck). Different types of experiences were discussed, and students formalised the notion of probability of an event.

FINAL REMARKS

The social marking (Doise and Mugny, 1981) of this game was an essential element in this process. It clearly contributed to students' engagement and performances. It underlines the importance that an adequate choice of the nature of the first tasks may have throughout the whole school year as it is in the first classes that many students decide to make an effort in Mathematics learning, or to give up.

Students' reactions were very diverse, as illuminated by some students' voices through their accounts. Initially they were surprised and doubtful because they had never played a game in Mathematics classes, except when there was a special occasion/festivity. But at the same time students were engaged in the game, and then in the second task because they did not directly associate it to Mathematics contents. Only by the end of the task had they realised they had been doing Mathematics work. Thus, we observed in both classes that despite the cultural differences between the two schools' cultures, this game was a great way to begin a new working methodology because while playing it students needed to interact with their peers, discussing ideas and strategies in a good atmosphere.

Students' statements illuminate they never thought it was possible to learn Mathematics through a game. Moreover, a game they were used to playing. This was also a very interesting contribution of this type of work because they understood that Mathematics can be present in everyday activities. Thus, we can say that we had two battles and also two victories.

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