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Making Decisions about Gambling: The Influence of Risk on Children's Arguments

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Abstract : This article presents results from a study on decision-making towards eventual participation to gambling activities by grade 4 students. For this study, six learning situations were proposed in a fourth grade classroom. The researcher, who was also the teacher, proposed some extra activities in order to define gambling. Students learned about probability and developed, at the same time, the ability to think critically about gambling. She then proposed three fictional situations of gambling to the students, and asked them if and why they would (or would not) participate in the situation. By studying the arguments that students provided, she explored how students' probabilistic reasoning and critical thinking can influence their decision making towards these activities. This study therefore focuses on mathematical mobilization of resources in a citizenship approach. Results suggested that mathematical, sociocultural, and personal contexts were the determinants of which perspective the students were situated in. The results obtained show that the students' arguments were based on a variety of aspects: the affectivity towards a game situation, the ethical aspects of the proposed activity, the affective conceptions towards the random effect, or finally the mathematical aspects of the situation. Students were also able to talk about the risks they faced when participating in those gambling activities.

Keywords: decision making, gambling, risk, probability, critical thinking, mathematical context, citizenship competencies.

A Social Problem: The Risks Associated to Gambling

Gambling activities are part of the popular cultures in many societies (Korn & Shaffer, 1999). Gambling activities are activities where the outcome is mainly or totally based on chance and where there is an irreversible stake of money, object or action (Arseneault, Ladouceur, & Vitaro, 2001; Chevalier, Deguire, Gupta, & Devereinsky, 2003). It is impossible to control or predict with certainty the outcome of the activity, even if some skills might be used in the activity. For instance, it is possible to make qualitative estimation of the chance of having the winning hands when playing poker. With the development of communication technologies, online gambling activities are now known worldwide, driven by the success of televised poker tournaments, online casinos and interactive lotteries (Chevalier & Allard, 2001). Risks involved in gambling activities are more often than not related to losing money. Gamblers lose money and then want to participate more to win their money back. This well-known phenomenon is referred to by psychologists is called "chasing losses". For some people, these particular activities can create a certain addiction that is sometimes hard to get out of and these addictions can have negative consequences on them and their surroundings (Ladouceur, 2000).

Some countries like Canada do not allow minors to gamble (Campbell, Derevensky, Meerkamper, & Cutajar, 2011; Chevalier & Allard, 2001). However, it seems that children do play these games (Campbell et al., 2011). In fact, children start participating in gambling games before the age of 12 (Griffiths & Wood, 2000; Gupta & Derevensky, 1998a; Ladouceur, Dube, & Bujold, 1994; Tremblay, Huffman, & Drabman, 1998; Wynne, Smith, & Jacobs, 1996). According to an important study conducted by Ladouceur, Dubé and Bujold (1994) with 1,320 elementary students from ages 8 to 12 living in the Quebec region, 86 % of the students had already won money and 37 % of them had even

offered up one of their important possessions in a game. Some of these students had even won big amounts for their age, and more than 40% played gambling games at least once a week. Amongst these students, lottery-type games were the most popular, followed by bingo, card games, sports bets, specific event bets, video poker and finally slot machines. Works from Felsher et al. (2004) on the topic of lotteries reveal that the average age of children that play instant scratch games is 10 years old, 11 years old for lottery draws and 12 years old for sports lotteries. Not taking into consideration their degree of implication in those activities, sports lotteries is the most popular amongst children of all ages (Felsher, Derevensky, & Gupta, 2003). Lotteries form the first introduction to gambling games. Since the risks associated to lotteries are perceived by the general population to be negligible and that children do not seem themselves as vulnerable towards them, the popularity of lotteries remains very strong. Additionally, the promotion and positive publicity of these types of games seems to entice more people to engage in these games.

Gupta and Derevensky (1998b) argue that the status of the "social player" among teenagers, quickly becomes problematic player. According to the researchers, young people tend to develop a growing interest in these activities, which has the effect of increasing their participation and also the stakes. Unlike other types of addiction like smoking, alcohol or illicit substances, it is difficult to identify problem gambling among adolescents, because the manifestations of this addiction are not apparent (Lesieur & Klein, 1987). It is still possible to assess the degree of participation in these games by observing the adoption of high-risk behaviors, such as drinking alcohol, smoking or drugs (Proimos, DuRant, Dwyer Pierce, & Goodman, 1998). The more a teenager plays, the more likely (s)he is to manifest these behaviours. For example, some teenagers will instead use the money they have to purchase a meal for playing slot machines or other activities (Fisher, 1992; Griffiths, 1990; Hardoon, Deverensky, & Gupta, 2003; Wynne et al., 1996). The gambling habits of young problem gamblers push them to engage in risky and delinquent behaviours such as substance abuse, alcohol, theft and vandalism (Chevalier & Allard, 2001; Dickson et al., 2004; Fisher, 1992; Griffiths & Wood, 2000; Proimos et al., 1998. Winters et al., 1993. Wynne et al., 1996).

Teenaged gamblers have generally a negative attitude towards school (Wynne et al., 1996). These youth are so concerned with their gambling activities that they lose focus in attending and participating in lessons and being successful in exams (Derevensky & Gupta, 2001). Teenaged gamblers show a decreased interest in all components of academic life: studying, working, attending school, and developing positive relationships with school staff. Being late, absenteeism and delinquency are also common for these students. The consequences of these attitudes and behaviours are numerous: the declining school performance leading to failure, students go through sanctions: expulsion and even student dropout (Chevalier & Allard, 2001). Troubled youth are more likely to participate in gambling and deal with addiction because of their low grades, various hiccups from their personal history and the high dropout rate (Fortin, Ladouceur, Pelletier, & Ferland, 2001). Students with learning disabilities also show higher risks of becoming addicted (Marotta & Hynes, 2003). Low self-esteem is a common cause of adolescent gambling (Chevalier & Allard, 2001; Gupta & Derevensky, 1998a).

When gambling, youth and adults experience dissociative reactions. Gamblers experience cognitive illusion; they think they have a control on the gambling activity, which Langer (1975) named illusion of control. They think that external power, such as luck, faith or God might help them win. Usually, they don't perceive the risk of losing or being addicted because they believe in their good fortune. Additionally, they are detached from the reality around them because their cognitive functions are fully focused on the game (Gupta & Derevensky, 1998a; Ladouceur, 2004). In a gambling situation, the player loses track of time and feels another person. He feels out of himself and looks outside playing. In a trance, he loses his memory (blackout) of events that occur when playing (Jacobs, 2000; Rossen,

2001; Wynne et al., 1996). Among adolescents surveyed by Wynne et al. (1996), 75% of adolescents who were experiencing gambling problems reported losing track of time in a game situation and only 24% of those who were not experiencing gambling problems said they encounter this problem.

Teenager gambling is prevalent worldwide (Jacobs, 2000; Shaffer & Hall, 1996) and in many cases, it is perceived as an harmless pastime (Campbell et al., 2011). Teenagers gamble for fun, excitement, a challenge and for making money (Wynne et al., 1996). They gamble also for supporting charity, to pass the time with friends and out of curiosity. Thus, gambling may lead to positive emotions. Consequently, parents also do not seem to perceive the risks of gambling (Campbell et al., 2011). Yet, teenagers are at risk to develop an addiction to gambling. Teenaged gamblers do not see themselves as problem gamblers. Based on the work of Hardoon et al. (2003), teenagers minimize the severity of their problem. When they finally agree they need help, teenagers have serious family problems, social, academic and legal.

An addiction to gambling is hard to treat and thus, prevention is the best way to protect teenagers against risk (Ladouceur, Boudreault, Jacques, & Vitaro, 1999). This prevention should start before the habits of gambling begin to develop. Thus, it is important to provide students with the tools for gambling prevention as early as elementary school (Crites, 2003). Since children do not have the knowledge needed to evaluate the probability of winning as well as the risks of dependency associated to a particular gambling game, it is the school's responsibility to play its role and to give children the tools needed to do so. It is not enough to give students knowledge about the topic. A prevention movement about gambling games must be supported by the development of mathematical competencies and also citizenship competencies like critical thinking and decision-making.

The development of citizenship competencies as a way of prevention

Legendre (2004) reminds us that a competency is complex since it is the product of a dynamic organisation of its components. The mobilization of a person's resources represents more a competency than an accumulation of knowledge. It is by using and orchestrating its resources that a person demonstrates his competency (Perrenoud, 2002). The knowledge used is transformed through this process and it is thus an opportunity to expand the knowledge. Citizenship competency can be developed through the development of mathematical competencies. Ten Dam & Volman (2004) inform us that the goal of a citizenship competency is that each person as a member of a community of social practices participates in a critical and responsible way to the practice in question. Each member of a society participates in a democratic way to its evolution. It means that each member of the society has to be able to make choices and knowing why they are made, has to respect the choices and opinions of others, has to discuss the choices made, has to make his own opinion and has to share it with others (Halpern, 2003; Paul & Elder, 2001; Swartz & Perkins, 1990). Decisions can be made on the individual or collective level, depending of the needs of the person.

Making a decision implies consequences for oneself and others; there is an individual and social responsibility (Swartz & Perkins, 1990). Usually, the choice made tends to be oriented to instant gratification or pleasure, short-term effects (Paul & Elder, 2001). Considering long-term decisions requires a deeper thinking and self-discipline. Some consequences of long-term decisions can be known immediately or can be found later (Paul & Elder, 2001). According to Swartz & Perkins (1990) making a decision means generating and exploring different options and assessing them in order to find the best choice. Intuitively, one option usually emerges as the most desirable, but further consideration usually leads to select another option. Taking into consideration personal feelings is also part of the evaluation

of the options. Identifying and recognizing needs are also part of the decision-making process, because they help to generate options. Halpern (2003) stated that this process takes in consideration personal characteristics such as values and knowledge, cognitive and cultural bias, and environmental variables (availability of an object for instance). Assessments reflect the "pros" and "cons" of the options and so rely on probabilities, possible consequences and possible risks or benefits involved. It comes to choosing the "best" option, but the best for whom? And by based on what criteria? Is the "best" option on a short or long term? These assessments should be critical to select an option that can meet the criteria identified by the person. Halpern (2003) raises an interesting point: the decision involves uncertainty about the outcome because we cannot know in advance the consequences of our actions. It is therefore important to be creative in the decision process to assess the maximum possible contingencies for our own wellbeing and that of others. Taking into consideration the context is also important, because the context is composed of socio and cultural factors, the kind of decision to make (for short or long term), technical issues or personal implications (importance of the decision). The process is dynamic and iterative: the nature of the decision, the context, or the options could be changed through it.

Critical thinking is intrinsically linked to decision-making process and contributes to identity development. Lipman (2003) believes that critical thinking has the function of facilitating the judgment based on criteria (including models), being self-correcting and takes into account environment. Criteria define the reliability and validity of a judgment; they are the basis of justification and comparison. Self-correction of critical thinking is by a self-assessment of thought, to correct our own mistakes. Taking into account environment or context involves to consider five aspects that can reflect and provide an overview of the circumstances and limitations of an event: 1) exceptional or unforeseen circumstances; 2) contingent or special constraints limits; 3) of an overview; 4) the possibility that the example is atypical; 5) the possibility that meaning is untranslatable from one context to another (Lipman, 2003). Taking into account the context allows one to determine the relevance of the criteria, to relativize the judgment and consider the implications. Affectivity is also part of the process to think critically, because attitudes influence thinking (Yinger, 1980). Personal values and biases have a strong influence on our cognitive structure and our implicit theories. Their influence colors every aspect of our thinking, but it is particularly strong in situations that require judgment or decision making about emotional or emotional issues (Yinger, 1980). Some attitudes are constitutive of critical thinking, such as respect for reasons produced (beliefs, actions and values) and respect for others and the intellectual authority. The latter is an attitude that is oriented towards research and inquiry, openness mind, the correctness of perspective, honesty and intellectual courage (Bailin, Case, Coombs, & Daniels, 1999). Note that critical thinking leaves room for doubt by giving up common ideas and in that sense, it is emancipatory. Creating a judgement or a point of view means also to be able to justify it. Explanation and justification are two different things (Duval, 1992-1993). Explanation allows production of reasons, while argumentation leads to examine the acceptability of these reasons during a justification. The acceptability of arguments is made based on two criteria: their strength and their relevance. The strength of an argument is based on two factors: the resistance against-one counter-argument and its epistemic value, defined as the degree of certainty or conviction tied to a proposal (Duval, 1991).

Critical thinking can be used in mathematics classes to examine, report and evaluate all aspects of a situation or problem, including collecting, organizing, storing, and analyzing information. Students need to be able to draw their own conclusions from the information and be able to identify inconsistencies and contradictions in the data (Krulik & Rudnick, 1999).

An Ethnomathematic Approach to Study the Probabilistic Structures

Inspired by Mukhopadhyay & Greer (2001), I developed an ethnomathematic model in order to construct learning situations with probabilistic structures (Vergnaud, 1990). This model contains three distinct contexts: sociocultural, citizenship and mathematical (Savard, 2008). The sociocultural context constitutes the starting point of the learning process by studying a particular object. This study can lead in to finding answers using mathematics. In that case, the mathematical context proposes a de-contextualisation of the object by means of mathematical “modelization”. The results are then retaken to the original context in order to study the implications of the results on the object. The mathematics learned throughout the process can therefore serve as an assist to critical thinking and decision-making in the citizen context. The goal of this model is to take into consideration the complexity of an object or a phenomenon in order to make “sense” of what has been learned during the realisation of the process. In that sense, this model can also be used as a theoretical tool for implementing interdisciplinary approaches (Savard, 2011).

The learning of probabilistic structures has been studied under the angle of random events. In their work, Piaget and Inhelder (1974), Green (1988), Fischbein et al. (1991), Watson and Kelly (2004), Falk and Wilkening (1998) and also Jones *et al.*, (1999) focused on studying students’ comprehensions about certain random events. Other researchers have focused on the teaching of probability at the elementary school level (Brousseau, Brousseau, & Warfield, 2002; Medici & Vighi, 1996). In fact, the probabilistic structures can take 3 different forms: theoretical probability, empirical (or frequentist) probability and subjective probability (Caron, 2004; Konold, 1991). Some of these works were able to orient research towards student’s probabilistic conceptions. In fact, Fischbein and Scharch (1997), Konold (1991), Brousseau (2005), Shaughessy, (1992), Amir and Williams (1999) and Kaheman and Tversky (1972) were able to identify certain conceptions that students had. Those conceptions are “explainable systems” that students give themselves in order to explain the result of an event. In this sense, they have their own domain of validity and we call them alternative conceptions (Savard, 2014). For example, students will explain the result obtained by throwing a 6-sided dice by the way it was thrown (Amir & Williams, 1999). This conception is called personalist interpretation. We have classified these conceptions according to the type of reasoning used: probabilistic or determinist (Savard, 2014). A probabilistic conception is based on probabilistic reasoning, where randomness and variability are key components. In the other hand, deterministic conceptions are based on the search of correlation between events. The deterministic reasoning employed does not allow a conceptual understanding of randomness and variability. The “conceptual complexification” (Laroche & Désautels, 1992) of these conceptions, which is based on the process of learning by restructuring new knowledge within the existing one, therefore permits students to pursue their learning.

In this project, I tried using mathematics to answer a social problem: children gambling. I also tried to answer the following questions: How do grade four students perceive risk in gambling activities before and after learning about probability? What arguments are made during the decision-making process towards participating in a gambling activity?

A didactical experiment with elementary students

The didactical experiment lasted six months. Before hand, I designed a teaching experiment (McClain, 2002) composed of six learning situations. I used my ethnomathematic model to construct the learning situations that would highlight gambling situations, a development of mathematical competencies, and a citizenship development. Two learning situations were designed for each type of

probability: subjective, theoretical and frequential (experimental). The contexts used in the two learning situations on subjective probability were on lucky charms and horoscope. Students were asked to do scientific experiments to test their lucky charms and their horoscope. Whole class discussions on their scientific experiments allowed them to express alternative conceptions, such as personalist interpretations or illusions of control in order to debate them explicitly. The contexts used in the two learning situations on theoretical probability focussed on dice and cards. Students were asked to do a bibliographic research on dice that included exploring a game board using two six-sided dice and exploring a deck of cards. Whole class discussions on their predictions allowed students to express some alternative conceptions about personalist interpretations and have them think about the meaning of the ratio (the number of favourable cases out of the number of all possible cases). The contexts used in the two learning situations on frequential probability were on spinners and coin tosses (Head or Tails). Students were asked to do experiments and record them. Whole class discussions on their results allowed them to think on the variability and uncertainty when addressing alternative conceptions, such as personalist interpretation. The researcher was also the teacher of this class of 27 fourth grade students (9 and 10 years old). The school was located in a suburban area of a larger city. All the teaching was done in French.

At the beginning of the didactical experiment (mid January), students were asked to draw their representations of gambling activities and then answer a questionnaire on their gambling habits and their knowledge on gambling and probability. Then, the six learning situations were implemented over three months. The students were given two formative assessments, one after third learning situation and the other after the last one. Those assessments were not graded nor reported as their learning performance (report cards). At the end of the teaching experiment, the students were asked again to draw their representations of gambling activities. The researcher interviewed each of them so they could explain the differences in their first and second drawings. Again, the same questionnaire was administered after the teaching experiment (mid April). I proposed three fictional vignettes at the very end of the didactical experiment two months after the students did their last drawings. Each vignette used a context that was closer to students' lives as much as possible. Those contexts were: a fund raising lottery, a coin toss game using personal objects, and betting on a race. The first two vignettes involved theoretical probability and the last one involved subjective probability. Each vignette was presented on different days. Students were first asked to respond individually on a sheet. The teacher/researcher collected them and facilitated a whole-class discussion on the vignette. After the discussion, students were again asked to write down what their answer to the question would be after the discussion on a new sheet.

Vignette 1: The Draw

A local youth group from your neighbourhood organize a draw to raise money for an organization. They sell 100 raffle tickets at \$1 per ticket. A big prize of \$25 is drawn. They asked you to buy a ticket with your money.

What do you do? Why?

How much profit will the local youth make?

Vignette 2: Coin Toss

Your friends propose to play a coin tossing game. Each participant puts an object that they like. The first of the three friends to get three faces in three tosses wins the objects.

What do you do? Why?

How many possibilities do you have to win the objects?

Vignette 3: The Bet

Your third neighbour thinks he or she is a race-running champion. But you know you can beat him or her because you are better than him or her. The neighbour challenges you to a race in the schoolyard. The first to arrive wins, and the loser has to give \$2 to the winner.

What do you do? Why?

Comments:

All the discussions on the learning situations and the fictional vignettes were audio and video recorded and the content was then transcribed into text format. A pseudonym was given to every student in order to preserve the confidentiality of each participant. The Atlas.ti software was used to code the data. I used a mixed coding: some codes were determined and others emerged from the corpus. The data was then interpreted using Deblois (2003)'s cognitive activity interpretation model. This model tends to describe the dynamics involved in the student's comprehension in a school learning process. It takes into consideration the student's representations of the situation, the procedures used and the expectations provoked by the didactic contract. The coordination between these components can lead to a partial or general comprehension in other contexts. We also interpreted the data using my enthomathematics model. Each student's answers was situated according to the context they belong. For example, answers given by students on probability belonged to the mathematical context, where answers describing gambling activities or illusion of control belonged to the sociocultural context. In this article, I will present findings from the drawings and the interviews, the questionnaires and the three fictional vignettes.

Findings

I will present the students' perception of risk associated with gambling activities and the arguments they provided in fictional gambling situations.

Students' Representation of Gambling: Their Perception of Risk

In answer to the first research question that studied how grade 4 students perceived risks in gambling activities, our finding showed that at the beginning of the teaching experiment, very few students were able to recognize the risks involved in gambling activities. Six students were unable to represent gambling activities. In the first drawing, they represented game boards instead of gambling activities. Among the 21 students who represented gambling activities, six of them represented losing money as risks associated to gambling, and one of them wrote about gambling addiction. The responses given in the first questionnaire showed similar results. Thus, betting was perceived as a challenge or a harmless activity. Only 5 students were able to recognize the possibility of losing something. Wager was also considered as a challenging and harmless activity. It was also considered as a winning activity by many students. Only one student recognized the risk of losing money. The six questions on chance and luck showed that many students responded in terms of illusion of control. They did not respond in terms of uncertainty and randomness. They presented the same thinking than pathologic gamblers.

At the end of the teaching experiment after the enactment of the six learning situations, the students' representations of risk changed. In their last drawings, only three students as opposed to six still confused board games as gambling activities, and five students were able to make distinctions between games of chance and gambling. The risks associated with losing something were also represented. Students were able to talk about addiction because four of them talked about relatives who had an addiction in one of the learning situations. They said that they developed new knowledge towards

those activities. Awareness to addiction is a fundamental aspect to preventing pathologic gambling; the assessment of probabilities of winning is another. In the second questionnaire, results suggested that betting did not seem to be problematic anymore because students were more cautious about the stake on question 1. Wagers seemed to still focus on winning on question 16. Some illusions of control were still present on the second questionnaire, but they were less frequent in all the questions asked.

The students admitted to participate in gambling activities. Many of them gambled, but it looked harmless to them because it was done between them.

Students' participation of gambling activities. In the questionnaires, two questions were asked to students in regards to their gambling habits. At first, they were not sure about their participation because many of them were confused with the expression: "I bet that". After reading carefully the questions, they saw that betting was linked with an object or money. The results of Question 2 (Did you already bet?) were surprising. Ten students in the first questionnaire, and 14 in the second said they had gambled. Several reasons may explain this discrepancy. First, some students might have started to play for the first time in the interval between the two questionnaires. Second, students might have been able to recall having participated in a bet because of the context in the learning situations that served as a trigger. Third, students may have been more attentive to the types of activities that occupy their leisure time, since the learning situations led them to think about different types of activities. I believe that the learning situations were not an incentive to play, but that possibility existed nonetheless.

The answers to Question 3 (If you've ever participated in any of these activities, circle which one or ones: Marbles [the winner kept the marbles]; Lottery tickets [6/49]; Dice when betting something [ex: an object or money]; Cards when betting money; Spinner games betting money [ex: fair]; Scratch tickets like seen on tv [ex : popular tv show name]; Betting an object [ex: cards, figurines, ...]; Betting an action [ex: a service,...]; Betting money; Participating at a drawing by buying a ticket; Head or tail when betting something; None of theses answers) of the two questionnaires show that the game of Heads or Tails seemed the most popular. However, students used this activity to determine the winner of an object or to determine which player would play first rather than bet. It was a way to make decision instead of a challenge. Some activities such as lotteries are prohibited for children under 18, but students said they have participated in these activities.

Visual representations and interviews. The first drawings made by the students showed that 21 of them knew some gambling activities. The first 27 drawings were classified based on students' representations. Four categories appeared in the light of the representations. The first category was not a gambling activity; it was related to board games.

1. Board games: 6
2. Casino activities: 11
3. People who gamble: 4
4. The emotions of people who gamble: 6

Popular activities in the casino (slot machine, roulette and blackjack) were represented. Four students associated the number 7 to casino operations.

Figure 1. Students' representations of gambling

The visual representations drawn by the students show that these adult activities were familiar to them. However, there appeared to be confusion between such activities and board games such as Monopoly. Indeed, the money from these board games was an element of confusion for some students. They wondered about it aloud when performing the activity of drawing. In the drawings, students also represented adult characters playing. Six students were positioned in a citizenship context: they chose to represent the emotions of people who gamble. The characters expressed emotions and text in the drawings helped understand them. Unlike the other drawings, these drawings were dynamic: they were drawn like a cartoon. The characters spoke or explanatory text described the representations and in general, the drawings represented a moral (four drawings). This moral vehicled the following message: gambling a lot leads to losing money. The participants seemed to express an addiction to many gambling activities where people bet their money earned and they stop when they lost everything. One student even highlighted the savings to show the money obtained. This student expressed being against making money easily and losing all easily too. It is possible that an implied contract could have been established between the teacher and students. This contract would have shared implicit expectations with teaching contract as it was presented. Thus, this implicit contract could have led students to believe that this type of activity is not acceptable:

In the second drawings, students' representations were different. Although the first category was not related to gambling, it was still present. The three categories were changed to reflect the evolution of the students' representations:

1. Board games: 3
2. Gambling activities: 14
3. Distinction between games of chance and gambling: 5
4. Gambling as a risky activity: 5

Changes in the categorization of the final drawings showed that students were more familiar with gambling activities. Indeed, the categories were refined since a category on the distinction between games and gambling emerged, and one of them changed. The category on emotion changed to a category called gambling as a risky activity. Four drawings represented gambling as losing money and one drawing represented an addiction to gambling.

The interviews with each student revealed that some students still confused board games and gambling activities. Board games do not cause addiction, unlike gambling activities. The risks of addiction was also one of the areas identified by some students during the interview. The scope of participation, the monetary loss and the hardness to stop playing was cited as the information learned in the learning situations. Students talked about some personal experiences with gambling when discussing their drawings:

Annie: Hello Magalie, can you explain your drawing?

Magalie: I have done a drawing that represents the casino and then for me what that means is the casino is just wasting your money. Here I did: I lost \$ 1,000 I lost \$ 10,000 and \$ 2,000.

Annie: And why is it losing and people will go to the casino to win?

Magalie: because they say: oh I will bet on so many businesses, as I think this time if it will be the lucky one, while I think it's really lost. I say that because my grandmother owes a lot of things to the casino.

Annie: She owes a lot of things? What do you mean?

Magalie: She owes a lot of money to just anyone.

Annie: Ok, she borrows money to gamble. Your own grandma?

Magalie: Yes.

Annie: So gambling and you have drawn a casino.

Magalie: Yes. Because that is what makes me think of gambling.

Annie: So everything we see here is people who lose. Is that right?

Magalie: Yes.

Four students mentioned knowing relatives who have an addiction. On the other hand, some students qualitatively assessed the probabilities of gambling situations. Their assessments were supported with correct mathematical knowledge. I believe that these students now had some knowledge allowing them to evaluate other gaming situations. In this regard, a student showed the use of a quantification of probabilities to encourage gambling:

Annie: Where are these people?

Sarah: In the casino.

Annie: Okay.

Sarah: And then they say they can make money. Then I forgot to write probabilities ...

Annie: You wanted to write the probabilities?

Sarah: Yeah, I wanted to write one chance out of ...

Annie: Why probabilities at the casino?

Sarah: Well, because it can encourage people, they say maybe it would be the fiftieth ...

Annie: That would be the fiftieth? What do you mean?

Sarah: Well if it's a 50 chance of winning maybe people will say it's the fiftieth time they play and they have not won. Maybe I'll win (E.671).

This student adopted the posture of a casino tenant to entice people to play instead of the posture of a gambler.

The changes in the categorization for the final drawings show that students were more familiar with gambling activities from a sociocultural context. The categories were refined since a category on the distinction between games of chance and gambling emerged, and one of them had changed. A category on emotions when gambling became an emotion-focused in a loss, also showing the possible addiction. The five students who made those drawings were located in the citizenship context.

The questionnaires. In the questionnaires, nine questions were asked on gambling activities and luck. The results of the first survey Question 1(What do you think it means to bet?) showed that the bet is more understood as a challenge or as a harmless activity. The emotional aspect was also present in the material presented, since you could lose or win. The answers to the second survey showed that the challenge of the activity became an issue that involved a bet that you could lose or win (9 responses more). Students thus abandoned the emotional perspective of the activity from the knowledge of its function. If students are more interested in how the activity works, it is possible that eventually they could end up being able to quantify the odds of winning in these activities.

Questions 5, 6, 8,10 and 12 were related to the affective conception named illusion of control. Some explanations of Question 5 (What are your chances of winning if you choose your lottery numbers? Circle the answer: Good - Better - Same - Worse – Bad. Explain.) showed that the control of chance is possible: the fact of choosing numbers affected the odds of winning. In the second questionnaire, six students have however shown the “complexification” of their affective conceptions and felt that the possibilities were the same, picking the numbers or not. The answers to question 6 (Can a lucky charm help you to win? Explain.) showed that the majority of students (14 out of 27) did not believe that luck had an effect on the chances (Q1 and Q2). According to them, a good luck charm could influence the location of a player by giving him confidence and therefore increasing the possibilities of winning. The explanations by students to question 8 (If your horoscope predicts you are lucky, are your chances of winning: Good - Better - Same - Worse- Bad? Explain.) were divided according to if they believed or not in horoscopes. Among those who didn’t believe in them, some explanation still showed that they might win. Perhaps students rated the situation from a probabilistic point of view, since it is possible that the event occurs. Note that in the second questionnaire, the responses to this question showed a clear tendency to question the effectiveness of horoscopes. Several events of illusion of control were revealed in questions 10 and 12 in the two questionnaires. Question 10 (Is there a number that is more lucky than others? Which one et why?) showed that students attributed certain famous figures as lucky. The students’ explanations to question 12 (In the game of the lucky wheel, are your chances of winning better if it is you who spin your wheel? Why?) showed few ideas related to the handling of deterministic conception. It was more the person making a difference when spinning a lucky wheel and not the action. These deterministic conceptions seemed to be in the complexification process when responding to the second questionnaire. Besides the fact that the students’ responses were less based on deterministic conceptions, the explanations were more based on mathematical learning acquired in the classroom.

In the first questionnaire, the students’ explanations to question 16 (What does wagering mean?) indicated that the action of wagering drove from affectivity in response to the challenges. Positive aspects about winning were mentioned by 12 students, but nothing about losing. One student said that it was wasting money. In the second questionnaire, three students mentioned the effects of chance in the context. These students showed that they might have considered chance in another context view. This category was not present in the initial questionnaire. However, seven students explained chance by

giving answers coming from other contexts of games of chance and gambling. The questions students have were linked, in both questionnaires, to gambling activities more than just prediction or chance.

Students' decision-making process about gambling activities

In answer to the second research question that studied the arguments deployed during the process of making a decision on an eventual participation to gambling activities, the results showed that the arguments were based on the affectivity manifested towards a gambling situation, on the ethical aspects of the proposed activity, on the alternative conceptions towards the random effect, and finally on the mathematical aspects of the situation.

Affectivity. The affectivity manifested towards a gambling situation had aspects related to the impact of the activity: the gains or losses from the activity or the challenge. For example, the vignette on the coin toss game showed that the emotions related to the choice of the object was the main argument to decide whether to participate or not because the students said they did not want to lose it. These students stressed emotions associated with the object by the consequences of its loss. Thus, they would be saddened or their friends would be sorry to have lost. The loss outweighed the possible gains. These students evaluated a greater risk. In the case of the vignette on the bet, some students explained that some players could participate more in order to recover the money lost in betting. Early in the discussion following the writing assignment, the value given to the objects was the key point to decide. This was the possible loss of the object that override the possibility of winning. In some case, the gain didn't seem to be highly considered, the emotional value predominated. Decision-making was based here on the possible gain or loss of the object and not on the mathematical possibilities of winning. Besides, if the issue was not an important object, it became easier to participate, because the gambling would have a positive impact: it would be a winner and the other friends would have no trouble losing their object. Yet it was the opposite argument used by another student in the case of an item worthless to him because he cared about the feelings of his friends who might lose if he won. He based his decision on the emotional aspect of the result: two losers and a winner. This emotional aspect was actually an ethical argument against the consequences of the game. One student said she didn't like this type of game and that's why she said no. She did not provide other reasons. Knowing the student and her family, I think that her religious beliefs disapprove gambling activities.

Early in the discussion on betting for a race, many students expressed their rationale for participating or not. The reasons were based on losing or winning money and on the dangers of the race. For losing or winning money, some students explained that their decision was based on the amount involved because they did not want to lose large amounts, but would participate if it was a small amount. As for the dangers of the race, the discussion targeted two reasons: the danger of being injured and of becoming addicted to gambling. The danger of being injured could be caused by falling, getting hit by a car or hustled in the race. Winning money, having fun or trying to win back the money lost were the dangers associated to being addicted to gambling. In other cases, as in the vignette of the draw, students said they wanted to earn the amount of \$25. Some were looking for a monetary gain. The money at stake was the element considered by the students to decide whether to participate or not. Six students chose to participate with hopes of winning while three chose not to participate because of the risk of losing. One of these students based his thinking on mathematical aspects to assess its low probabilities of winning while another evaluated the small amount of profit.

Affectivity was also linked to the activity itself. Students based their decision on the assessment of this activity: like tossing a coin or not liking betting. Others wanted to take up the challenge proposed by the race. Provocations linked to betting could encourage them to participate. Some students wanted to prove that they were better runners than the neighbour. The money was not taken into consideration.

Some students said that they would have run without the money, because racing was fun or because they didn't like betting. Two students added they would not participate because of their religious beliefs. Students who based their answers on this aspect were located in the citizen context.

Ethical aspect. The ethical aspect of the proposed activity could be declined under three aspects: the purpose of the activity, the impact of the activity, and the risks involved during the activity. The goals of the activity in the vignette on the draw related to the money raised. Students based their decisions on the support they would make to a charity. For 16 students, the support provided to an organization was the central argument that influenced their decision. They based their decision on the ethics of the situation instead of their personal comfort. Some even said that it was a gift and that the gain was not important for them. They chose the ethical aspect of the context as a criterion for deciding whether to participate or not. This instance highlighted how the purposed of the activity influenced their decisions. Others said that they did not know where the profits raised would go, and it was the central argument in their decision-making. The two students who questioned the integrity of the organization questioned the validity of their ethical action, as they assessed the charity organism before deciding if the ethics was important enough to invest money. They also took into account the context and were given criteria to decide. It showed the impact of the activity. For instance, in the discussion following answering the vignette, a student raised the legality of buying lottery tickets:

Marco: A lottery, is all the time 18 years old and over. Well, we were not supposed to buy it, that I would say no there (V1.202).

The student questioned his participation from a legal point of view. While the discussion addressed the ethical aspects of the money raised, it addressed a critical aspect in a decision-making: evaluating options from a legal point of view. This awareness led to a student to consider saving money rather than to enrich himself, slippery wealth sharing to increase his personal wealth. The discussion moved them to personal wealth.

Students reported that there were risks in gambling activities,, such as having a physical injury during a race or hurting others. Students also mentioned the risks of addiction to gambling and money. Students who based their answers on this aspect were located in the citizen context.

Alternative conceptions. Alternative conceptions of chance involved the illusion of control or religious beliefs. In the vignette Heads or Tails, for example, two students relied on affective conceptions on chance. One considered that the face side of the coin was luckier while another considered himself unlucky: she wrote that she doesn't have much luck. In the discussions, a student said that he wanted to cheat when tossing the coin. He wanted to participate, since he believed he could control the outcome of the game. He showed a deterministic conception of the personalist interpretation. He thought that he could control the outcomes.

During the discussion on the vignette on the bet, two students based their decision on their religious beliefs that prohibited betting. Students who based their answers on this aspect were located in sociocultural context. Students who did express alternative conceptions did not mention any risk associated to the activity.

Mathematical aspects. The mathematical aspects of the situations were related to the theoretical and subjective probabilities of winning. Students who based their answers on these aspects were located in the mathematical context. For instance, the proposed context on the draw was a great influence on the decision-making process since the arguments used by the students were mainly based on the support given to the charity rather than participating in gambling activities. When the sociocultural context has

shifted to a mathematical context, students considered the money invested, the money involved, and the money raised. The arguments used then were based on mathematical facts:

Mia: Well, I say no because even if it's just for \$1, then, well you've don't really have too much chances of winning if you buy a ticket. You have one chance in 100 of winning (V1.182).

Another student compared the possible benefits of buying a ticket. She addressed the expected gain. She based her rationale on the quantification of the gain and not on the probability of winning:

Magalie: I would say n, because first, they will have the triple in their pockets. Then, he said that just \$1, but maybe you have ... basically, is that you do not earn \$25. You win, you win \$24. That is like a catch because you spent \$1 and won \$25. At the end, you won \$24 (V1. 182).

She estimated that her probabilities of winning were low. She took into account that all the tickets would be sold to show an awareness of the concept of the relative theoretical probabilistic structures, or 1 chance in 100. In fact, where the money went was more important than the money to be won. In fact, it was the only risk involved given the fact that the majority of students did not care about winning or losing money in this case. The citizenship context used all the space and obscured the mathematical context.

In the vignette on Heads or Tails, two students relied on mathematical aspects, specifically on the equiprobability of the outcomes. In the discussion, a student thought that all friends had the same chances to win: 1 chance out of 3. He based his decision on the mathematical aspects of the situation. He based is quantification on the number of participants rather than the number of throws to assess probabilities. However, it was fair to say that the participants had the same chance to get face-face-face or 1/8. He was not the only student that made this confusion. Another student was not able to think about the number of possible cases because she thought about counting all the attempts made by the participants. The context of gambling dominated. In fact, the gambling situation took all the space because another student did not see the need to focus on the mathematical context since in any case, she did not want to risk losing an object and had no chance of winning:

Mia: That's because I, if I'm not involved, I cannot really have a chance to win (V2.282).

She did not show any awareness that the count of her probability to win could have helped her decide whether to participate or not. Only the assessment of the object led her to decide. On the other hand, another student was not able to count them because it was not possible to predict the next outcome anyway. That student confused the enumeration of probabilities and the outcome of the gambling activity. Doing so, it was impossible to use a mathematical argument to support his decision.

The teacher then asked the students to individually answer the question on a blank sheet. The study of the students' productions showed that 7 students counted the throws. Four students answered 1/8, when a student forgot some cases and answered 1/6. A student counted eight possibilities but said 3/7 because "you cannot have just face-face-face because everyone would win all the time." A student counted the combinations instead of the permutations and replied $\frac{1}{4}$. Some students took into consideration the players and the throws: six students answered 3/9, seven students answered 1/3, and one student answered 3/3. Four students used a deterministic reasoning by saying that it was chance. A student showed a conception of personalist interpretation because he said that it depended on the player,

In the case of the vignette on the race bet, two students relied on the information available to them to assess the situation. They evaluated qualitatively the subjective probabilities to win:

Melissa: For me, it depends. If I know I will win, then I may be saying yes, and then if I know I can lose, or you know I can lose my \$2, then I will say no. You know, what I mean by that is, I might already have done a race against that person then I won ... maybe (V3. 37).

Martin: If ... it was not running but cycling, it would not have been hard, I would have immediately said yes because ... I think I would be able to beat him (V3. 319).

Students did not often use the use of probability to justify a decision.

Discussion

This study led to the emergence of four themes that identified the arguments used by elementary school students to support their decision of whether to participate or not in a gambling activity. Some students linked their reasons toward the risks to lose money or object, being injured, making sad their friends or being addicted to gambling. In fact, the risks were involved into three themes: the affectivity manifested, the ethical and the mathematical aspects. No risk was mentioned in the alternative conceptions theme.

Wynne et al.'s (1996) work allowed me to compare the reasons that explain the participation of different teenager gamblers: teenagers without problem, at-risk or pathological gamblers. The motivations raised by adolescents related to the emotions shown towards the gambling situation, the ethical aspect of the proposed activity and distractions. The results from this study suggest that elementary school students also justify their participation by the emotions shown towards the gambling situation and the ethical aspects of the proposed activity. However, unlike the teenagers surveyed by Wynne et al. (1996), the students in this study also justified their eventual participation by alternatives conceptions toward chances and by the mathematical aspects involved in the situations. I hypothesized that the learning situations enacted in this study would influence students' responses.

The four themes that emerged from the decision-making process by students can be categorized according to a predominant context. Thus, the alternative conceptions towards the random effect were elements that belonged to the sociocultural context. The mathematical aspects of the situation were elements that belonged to the mathematical context. The affectivity manifested towards a gambling situation and the ethical aspects of the proposed activity were elements that belonged to the citizenship context. The risks perceived by students belonged to the mathematical context or the citizenship context. It is interesting to note that those contexts might used to prevent gambling addictions.

The theme affectivity manifested towards a gambling situation, emerged more often from the students than the other themes. When students used arguments belonging to the this theme, they situated themselves in the citizenship context. The themes mathematical aspects of the situation, and ethical aspects of the proposed activity were not used often by the students to make a decision. It does not mean that they didn't consider them at all. They might have considered elements from the mathematical and the citizenship contexts, but they were not selected as key points to make a final decision. The decisions taken by the students did not all seem to have followed the process of decision making from the theoretical framework. Indeed, students reported that their religion forbade them to bet. In doing so, they did not seem to have generated more options to decide or re-evaluated their decision. I did not have access to the whole process to generate and evaluate all the options. Even if it was possible to grasp some options that were considered by the students throughout the whole class discussions, I did not have enough material to have a strong interpretation. However, I can say that the students used the context of the gambling situation as a central element of the decision-making process. The same framework had not only served to generate options, but was also used to justify them.

Another limit of this study was related to the students' perceptions of risk. Throughout the whole didactical experiment, the students were not asked directly about how they perceived risk. Instead, I wanted to know if it was a part of their general understanding of gambling activities. I didn't want to be bias or make judgement on their relatives who gambled. It could be perceived as a limitation of this study at this point, but the opposite could have affected the complexification process of their alternative conceptions, especially the ones related to the illusion of control. When we talked about those, some students mentioned how their relatives used lucky charms. If, as a teacher I presented those thinking negatively, it might have had created an affective conflict with students. Then, it would have been harder for them to think about those ideas from a mathematical point of view.

The vignettes proposed presented some limitations. Thus, the contexts proposed in the vignettes were inaccurate for some students. The context proposed in the first vignette was raise-funded tickets lottery. The number of tickets sold was not given to students; they had to assume that all of them would be sold. Students could not assess the amount of prizes because they represented a situation in which few tickets had been sold. In addition, determining the profit for the winner and for the organizer of the draw was a challenge for 15 students. Does it mean that understanding the distribution of money had an effect on the decision-making process? That could be a factor of some importance, since the fact that the profits of the draw would go to a charity organism had an impact. In fact, the choice of the charity organism was found to be an important aspect of the situation. Students evaluated the seriousness of the organizers of the draw instead of doing a mathematical evaluation. After the discussion, the students answered the second time the questions on the first vignette. The teacher added some information to the context that helped students to define it. Thus, the charity organism in question was a known and reliable one and all tickets were sold. These clarifications were required to discuss the same context for all.

The context presented in the second vignette asked to quantify the probability of a compound event when playing Heads or Tails, which students were not able to do. It was possible to make an experiment, since they had access to manipulatives. However, no student used the material to make the experiment and thus answered questions. Despite the fact that students have counted the results of throwing a coin, none reached a solution that showed an understanding of enumeration. Although the proposed location could be addressed from a theoretical approach, the complexity of the rigorous theoretical analysis of this situation might have allowed, at best, to calculate the probability of winning for one trial and use equiprobability to predict the probability of winning. During the whole-class discussion, the teacher asked a question about the mathematical background and she noticed that the students used the number of participants rather than the number of throws. She then wrote the following question on the board: What is the probability of getting face-face-face when tossing the coin three consecutive times? She explained the issue and asked the students to answer on a sheet. After picking up the students' sheets, the discussion continued on the procedures used to count the results. The teacher constructed with the students a tree-diagram to create the sample space. The calculation of a compound event seemed to require a representation of the situation that was challenging for fourth grade students.

The nature of the objects involved in this vignette was also very important. The students discussed more the objects than the probability to win. Their arguments were on the risks of losing a valuable item, the taste of winning objects, and making friends sad if you win. The probability to win and alternative conceptions were also arguments to decide in some cases. Again, the sociocultural context took over and left little room for mathematics in the situation. The main arguments were based on the outcome of the game and the risk of losing a valued object. Very few students used mathematical arguments.

The context presented in the third vignette was taken from school. The school environment brought students to visualize races conducted as part of the physical education classes. Some of the risks raised by students were those they faced when racing in the schoolyard: being injured or hurt by another student or a car (the street was pretty closed to the schoolyard). They also focused on the running skills of each participant, which was part of the information needed to construct the subjective probability. In this case, some students used a mathematical context to decide.

Despite these limitations, the vignettes were fertile fictional contexts. The discussions yielded important information about the context of gambling activities. They were important to clarify the contexts presented. It was also a nice opportunity for students to revise their initial thoughts. Interesting enough, after the discussion on the vignette Heads or Tails, two students made a decision based of the illusion of control, which they did not do that first. It seemed that those conceptions were hard to complexify and can live in parallel with other reasoning. In non-fictional context, much information must be processed before deciding and some of them require significant cognitive work. That's why students have to situate themselves in different contexts: citizen, sociocultural and mathematics to make a decision. Since the mathematical context is embedded within the two other contexts, it may be more difficult to reach it.

Conclusion

This study shed light on students' perceptions of risk in the case of gambling activities. Some students did participate at gambling activities by betting, money, action or object. Like Ladouceur et al. (1994) pointed out, they still have access to adult lottery such as scratch tickets. Prevention should be a part of the curriculum. Like drugs, cigarette and alcohol are discussed over the years in the schooling system, risk associated to gambling should be address when teaching probability. It is absolutely necessary to address it because even if the risks are not explicitly addressed, students might have alternative conceptions such as personalist interpretation and illusion of control when learning probability. These conceptions do not help assess the risks in a mathematical way. Those conceptions can live in parallel in students' mind and create an obstacle for developing a conceptual understanding of probability. Thus, supporting students to complexify their alternative conceptions should be part of the learning conditions created to develop probabilistic reasoning.

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