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Discussing Virtual Tools That Simulate Probabilities: What are the middle school teachers' concerns?
Discussion à propos de simulateurs virtuels des probabilités : quelles sont les préoccupations d'enseignants de mathématiques ?

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Résumé de l'article

Notre étude exploratoire a permis à des enseignants du Nouveau-Brunswick, Canada, de tester des simulateurs virtuels de jeux de hasard développés par une équipe de techno-pédagogues, d'enseignants de mathématiques du secondaire et de didacticiens du Québec. Lors d'entretiens semi-structurés, les participants ont semblé découvrir un riche potentiel contenu dans les scénarios pédagogiques et les logiciels. Les avantages soulevés ont trait au fait d'appuyer leurs pratiques, tout en motivant les élèves et en augmentant leur compréhension de concepts autrement difficilement accessibles. Les besoins d'un accompagnement techno-pédagogique et didactique ont été également ressortis.

DISCUSSING VIRTUAL TOOLS THAT SIMULATE PROBABILITIES: WHAT ARE THE MIDDLE SCHOOL TEACHERS' CONCERNS?

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ABSTRACT. Mathematics teachers, researchers and specialists in educational technology from Quebec, Canada developed virtual tools that make interactive simulations of games of chance. These tools were presented to a group of teachers from New Brunswick through workshops and they then got to test and validate them with their students. Semi-structured interviews were conducted with groups of teachers following the experimentation with the tools. Results show an appreciation of the rich educational potential the virtual tools bring and the pedagogical scenarios that come with them. Participants suggest that working with simulators would increase students' motivation and deepen their conceptual understanding of concepts that are otherwise hard to grasp. But they, however, lack professional development on how to teach probability and need techno-pedagogical and didactical follow-ups.

DISCUSSION À PROPOS DE SIMULATEURS VIRTUELS DES PROBABILITÉS : QUELLES SONT LES PRÉOCCUPATIONS D'ENSEIGNANTS DE MATHÉMATIQUES ?

RÉSUMÉ. Notre étude exploratoire a permis à des enseignants du Nouveau-Brunswick, Canada, de tester des simulateurs virtuels de jeux de hasard développés par une équipe de techno-pédagogues, d'enseignants de mathématiques du secondaire et de didacticiens du Québec. Lors d'entretiens semi-structurés, les participants ont semblé découvrir un riche potentiel contenu dans les scénarios pédagogiques et les logiciels. Les avantages soulevés ont trait au fait d'appuyer leurs pratiques, tout en motivant les élèves et en augmentant leur compréhension de concepts autrement difficilement accessibles. Les besoins d'un accompagnement techno-pédagogique et didactique ont été également ressortis.

Since the 80's, information and communication technologies (ICT) have been viewed as potentially powerful tools to guide students into a dynamic and progressive construction of knowledge (Hughes & Daykin, 2001; Savoie-Zajc, 2004). In mathematics education, the constant increase in the number of virtual applications puts into question their real contribution to the learning process. In fact, in the beginning of the 21st century, Garofalo, Drier, Harper, Timmerman and Shockey (2000) pointed out that the transition from traditional teaching methods using paper and pencil to a computer enhanced environment doesn't bring explicit advantages for the learner or the teacher. On the contrary, this kind of use can even create prejudice to the diversification of the use of ICT in schools by having them appear useless from a didactical or a pedagogical point of view (Grenon & Larose, 2006; Larose, Grenon, Lenoir, & Desbiens, 2007). In the past decade, many authors have suggested that the benefits of ICT integration are essentially at the contextual level (Freiman, Beauchamp, Blain, Lirette-Pitre, & Fournier, 2011; Jonassen, 2007). A recent book on visual mathematics and cyber learning (Martinovich, Freiman, and Karadag, 2013) emphasizes the experiential and collaborative potential of digital technology. The contextualization of learning by the implementation of numeric technologies and features of Web 2.0 tools, presents an interesting potential to enhance learning. Thus, these new technological tools allow a certain interactivity between the learner, the knowledge that is to be learned, and a more or less authentic context in which this knowledge is set, for example, within simulations, such as graphing calculators, websites (*ExploreMath.com)* or softwares (*The Geometer's Sketchpad; Microsoft Excel)* (Garofalo, Drier, Harper, Timmerman & Shockey, 2000).

Our research project puts into perspective the integration of digital technologies and teaching practices in mathematics education. More specifically, we focus on a set of relationships between mathematics as a conceptual learning process, the learners' thinking processes and teaching practices (Jonnaert & Vander Borght, 1999).

We created learning and assessment situations on the concept of probability in the context of gambling. These types of situations – although they are not usually experienced by schoolchildren in their everyday life – may be used to develop awareness of and sensitivity to the challenges that they can present. A better understanding of the role of probability and chance could help students evaluate their chances of getting favorable results in different contexts and eventually make socially responsible decisions (Savard, 2008). As part of a larger study that involved virtual simulators of games of chance used by Quebec secondary teachers (grades 7 & 8) and their students, a series of workshops were offered to 18 teachers from grade 6 to 8 in the province of New Brunswick, Canada. We interviewed them in order to investigate their perceptions concerning the developed tools, their use in the classroom, and their potential contribution to the learning process. All the teachers in both Quebec and New Brunswick were teaching mathematics in French. All the New Brunswick teachers were living in a French minority community. In this paper, we situate our data within culturally responsive teaching perspectives (Gay, 2000). Culturally responsive teaching has six components: it is validating, comprehensive, multidimensional, empowering, transformative and emancipatory. Validating means to recognize the cultural diversity in learning, while comprehensive refers to maintaining identity and connections within the community. Multidimensional aspects recognize the different dimensions of teaching: curriculum, learning context, pedagogy and classroom climate. This pedagogy empowers students to be successful in their learning processes by creating infrastructures to support their efforts. It is also transformative in the sense that students become productive members of their community and their society. Finally, it is emancipatory by making knowledge authentic. This framework allowed us to study the teachers' perspectives of using virtual simulators to enhance students' learning of probability in a French minority community. This framework allowed for more insights into how such tools can be used by teachers and what their concerns are in implementing them.

DESCRIPTION OF THE RESEARCH PROJECT

The tools presented to the New Brunswick teachers were developed in Quebec by a research team composed of teachers, a school board consultant and a web-specialist company, ScoLab inc. This company has also developed other web-based mathematics learning products such as Netmaths and Buzzmath. The researchers, in collaboration with four mathematics teachers and their school board consultant, developed and implemented the simulators (Theis & Savard, 2010). One of the authors joined the team during the stage of creating the learning and assessment situations integrating the simulators. Our research project aimed to develop the teaching of probability in the context of virtual gambling activities for grades 7 and 8 students. We were able to develop a virtual tool that simulates probability and probabilistic situations to be solved, and to analyze teaching practices using this tool. The Quebec teachers participated in the development and validation of the simulators, while they created other learning and evaluation situations (LES) that they used in class with the simulators, such as 6/49 Lottery game or roulette-style casino game.

Having New Brunswick teachers try out the project materials allowed us to look at them in another way. Teachers in New Brunswick have a different curriculum and different needs. Not only are they teaching in a francophone minority setting and facing demographic challenges, they also lack resources, both human and material ones, and have less opportunities for initial training and to continue their professional development related to pedagogical knowledge, didactical knowledge, and content knowledge (Bjarnadóttir, 2008; Cormier, 2005; Freiman, 2010; Freiman, Richard, and Jarvis, 2012). From a culturally responsive teaching perspective (Gay, 2000), these teachers offered some unique perspectives that the developers hadn't anticipated; therefore, their perceptions and experiences with the tools provided better insights into their pedagogical and didactical value, and also informed research and practice in this area.

We chose to develop the simulators in the context of gambling activities for two reasons. First, we wanted to focus on students' learning about the concept of chance in order to help them distinguish between chance, luck, hazard and randomness. We also wanted to modify their representations about control over chance, which could then help them make more enlightened decisions about their possible gambling participation (Larose, Bourque, & Freiman, 2010). The majority of teenagers who participated in gambling activities are at risk of developing an addiction to them (Ferland, 2005). Furthermore, Martin, Gupta and Deverensky (2007) showed that approximately 36% of Quebec secondary school students have participated in at least one form of gambling activity in a year. Among these, 3.8% were gamblers at risk of developing an addiction to those activities, and 2.1% were considered pathological gamblers. In general, 18% of student gamblers reported having problems with their gambling activities. These young adults have grown up in a technological environment where gambling activities, online or not, represent a popular activity, especially among teenagers (Larose, Palm, Grenon, Hasni, & Lessard, 2005). Furthermore, a study done in 2009 showed that 41% of the 256 teenagers interviewed between the ages of 13 and 16 years said that they played poker and 15% of them said that they played online for money (Theis & Savard, 2010). By developing simulators for this research, we wanted to grasp the probabilistic phenomena using an experimental approach. Since it is difficult to experiment manually using a large number of trials, the simulator seemed to be an interesting device for students in an authentic context of learning.

TEACHING PROBABILITY AND ICT

Different approaches in the curriculum

The concept of probability has three modes of construction (Briand, 2005; Caron, 2004), and each of them can be perceived in qualitative or quantitative ways: the theoretical approach, the frequentist (also named frequential) approach or experimental approach, and lastly, the subjective approach. These approaches are not linear levels of learning, but constitute different facets of the concept of probability. Thus, the theoretical approach represents the ratio between the number of favorable cases and the number of possible cases of an event when all the cases are equiprobable. This approach is largely used in learning situations presented to students. The frequentist approach is understood as a measurement of the relative frequency of an event in comparison to a reference set. Probabilities are reached through statistics, creating links between those conceptual domains. The third approach, the subjective approach or the Bayesian model, evaluates the measurement of the certainty associated with some events (Caron, 2004). The information we have about a phenomenon creates the evaluation criteria of some events, which can be personal (like ability and skills), social (election) or scientific (weather).

These three approaches are included in both Quebec and New Brunswick middle school curricula These curricula recommend using experimentations with 12 to 14 year-old students in order to help them construct meaning and create links between school learning and daily life situations. Using real-life contexts for introducing probability concepts is favored by some researchers (Borovcnik & Peard, 1996; Savard, 2008). We share the point of view of Munisamy and Doraisamy (1998) regarding the introduction of situations, which favor simulation and experimentation. They also put an emphasis on creating methods of collecting and organizing data by students. We believe that simulators might increase the potential of using appropriate situations to bridge daily life and school learning. The probabilistic reasoning can thus be developed in harmony with students' everyday knowledge.

Hernandez, Kataoka, and de Oliveira (2010) studied the probabilistic knowledge of 91 high school students aged between 16 and 19 years old. These students had weak understandings of probability. Their task was to throw a coin in order to determine, by chance, the order of visiting friends. They could use a coin (physical) and a simulator (virtual). The authors concluded that the students understood the distinction between a deterministic and a probabilistic experiment as well as the distinction between theoretical and frequentist probability approaches (Hernandez & al., 2010).

ICT for studying probability

Virtual tools are used at different school levels for teaching probability. Seal and Przasnyski (2005) have studied the benefits of using Microsoft Excel to simulate a casino-style roulette in university statistics classes. According to them, the use of the virtual environment made learning more attractive, but it also allowed the study of different game strategies without using complex mathematics.

Probabilistic simulations were conducted by a small group of students through the learning system "Kansas" (A Networked Shared Application Space). These simulations allowed students to conduct the same experiment many times using the model "observe – predict – explain" (O'Shea et al., 1993). Scanlon, O'Shea, Smith, and Li (1997) mentioned that the use of technology permitted students to gather results for a large number of trials. Nontheless, their capacity to construct explanations about the studied phenomenon was limited.

In order to study pre-service elementary school teachers' probability misconceptions related to the law of small numbers and equiprobability, Godino, Cañizares and Díaz (2003) proposed simulations to introduce students to the use of random number tables and to the idea of simulation. These students engaged in random simulations with manipulatives and random number tables and used the simulations to solve and reflect on counter-intuitive probability problems. According to the authors, the use of simulations helped the students address probabilistic conceptions in an authentic way (i.e., linked to daily life situations, such as probability of the birth of boys and girls in a hospital), simulate probabilistic events that are difficult to observe, make links between theoretical and frequentist probability, and create a new space for discussions and dialogues (Godino et al., 2003). Afterwards, a computer software, named *Statgraphics*, and Internet applets were used in this research. The authors argue that data obtained from simulations with large samples clearly showed the correct response and served to initiate a debate about the counter-intuitive results and about the usefulness of simulations to solve real probability problems. They had appealed to more cautious interpretations regarding the impact of this learning. In particular, they noticed some difficulties on the part of the participants to distinguish between the results of experimentation from the theoretical results, and to explain that the observed phenomenon was not influenced by the simulations (Godino et al., 2003; Batanero, Godino, & Cañizares, 2005).

Other researchers also studied the role of the virtual simulators (with or without physical manipulatives) in the development of probabilistic concepts based on students' misconceptions (Savard, in press). A study with grade 10 students was conducted by Bill and Gayton (2010), where the participants were given the task to throw a two-sided coin in order to notice different sequences of having a Head (H) or a Tail (T). For example, participants could record the results HTHTHT or HTHHTT after six trials. They were asked to explain the results and later compare their conjectures by doing computer-supported simulations using the software *Fathom*™. The authors found that teachers and students appreciated using physical and virtual tools to learn and apply the probabilistic concepts. The overall results of the study suggested that it was a good teaching strategy that allowed students to reach a deeper understanding of these concepts.

Konold and Kazak (2008) emphasized the importance of repeating probabilistic experiences to help students develop the concept and perception of chance and hazard at a young age, by working with results that varied from one experiment to another. According to the authors, virtual simulations using *TinkerPlots* could help students explore situations where two dice are rolled or the rotation of a spinning wheel is observed, thus strengthening the connections between perceptions and conceptions.

None of the studies presented in this section however addressed the teachers' concerns regarding the teaching of probablisitc concepts using simulators. In this particular research project, we wanted to study teachers' concerns toward a technological environment and its add-on value for teaching probability in middle school grades (6-8). For our analysis, we adapted a model developed by DeBlois (2006) based on the concept of "milieu" to focus on students' difficulties and teachers' response to the teaching interventions. In other words, we wanted to look at teaching and learning environments focusing on what teachers devote their attention to examining how these may influence the transformation of their current practices towards more innovative approaches.

Research question

As mentioned above, we have developed probability simulators that are specifically contextualized in gambling situations in collaboration with teacher-participants from Quebec. This virtual tool addressed their teaching constraints as well as the learning needs of their students in regards to the competencies targeted by the provincial curriculum. The province of New Brunswick, while having a different school structure (K-8 elementary and 9-12 secondary levels), recognizes probability as an important content in mathematics within their curriculum. In order to identify how useful the virtual simulators and the corresponding learning and assessment situations could be in this particular context, we will investigate the following question: What are New Brunswick teachers' concerns in regards to the virtual simulators and the learning situations?

Two rounds of workshops conducted with participating teachers were accompanied with group discussions that were recorded and analyzed by the authors, in order to reveal teachers' concerns related to the emergence of milieus that they are sensitive to and that tend to influence the implementation of new tools, such as virtual simulations. In the following sections, we describe our methods in more detail and discuss our findings.

METHODOLOGY

General framework

As mentioned previously, the virtual interface developed was put online and made accessible to all participating students and teachers subscribed to *Netmaths*[1]. The simulators presented eight situations to the students: a heads or tails game with a coin; a black-jack game; a game with dice; a game similar to the 6/49 lottery; a wheel of fortune; the Monty Hall problem[2]; a lottery simulation game (with or without replacement); and a roulette-style casino game. Each game situation in the virtual interface on the website contained multiple parameters and it produced a random representation of results in real time (or at a reduced speed) on a graph. The choices of simulators were in line with situations used in traditional classrooms, as well as in real-life situations, involving games of chance and gambling that might have been experienced or observed by students in their daily lives. Figure 1 presents the simulator used for playing dice games, where it is possible to select the number of dice (all with 6 faces), the pace ar which the dice are rolled, and the number of simulations. For instance, it is possible to choose two different dice to make a simulation game. In other words, it is possible to simulate an experiment with two 6-sided dice or with four 6-sided dice. Moreover, it is possible to select the pace which allows students to see the simulation case by case (pas à pas), that is, students are able to visualize the results on the dice. Selecting fast (rapide) simulation allows students to see the results on the dice more quickly. Turbo mode does not allow students to see the results on the dice because it is too fast. It is only possible to see the last result. However, turbo mode allows students to conduct a larger experiment in a few seconds. It is also possible to choose the number of simulations between 1 to 1,000 and to create the rules of the game. Those rules state that the player should pay $1 and receive a certain amount of dollars to be certain that he doesn't get number one for example. There are different choices that can be used to create these rules.

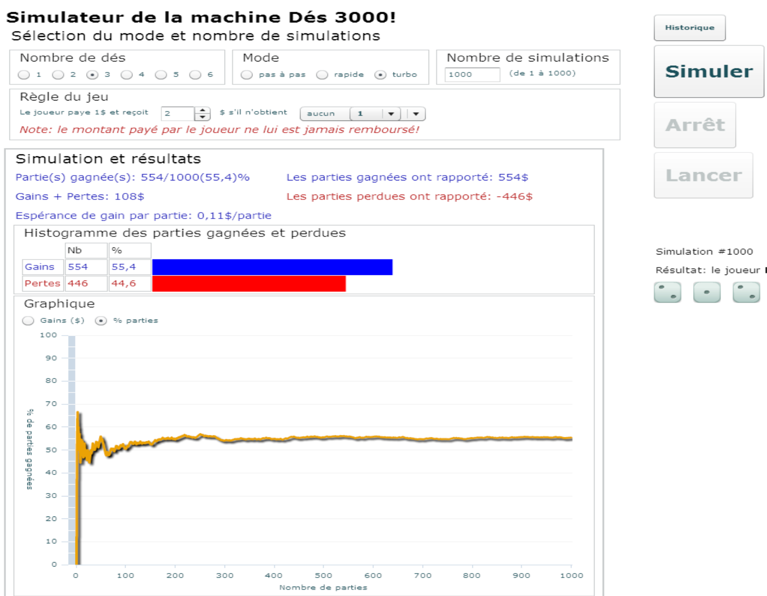

FIGURE 1. *Simulator of dice games*

In order to integrate the simulators into the context of learning and assessing situations, a special virtual environment was developed. By accessing the website "*Fête Foraine*" (Funfair) www.Netmaths.net/FeteForaine, students could choose one of the four attractions. Each attraction had the same structure and the games were promoted by a male or female host and explained by a virtual animator. In addition, there were two characters (male and/or female) for each game that explained to the participants how to play the game. One of the characters modeled more risk-taking in the game, while the other character tended to be a critical player. Students were asked questions before they played the simulators. They had the opportunity to develop and test their conjectures, which incorporated different conceptions about probabilities. The dynamic interaction with the virtual animator permitted students to problematize the situation proposed, think of a strategy, try out their chosen strategy by following a problem solving process in real time, estimate the probability of winning, observe the progression of the outcomes, and reflect on the chosen strategy in relation to the probability of winning once the activity ended. The situations featured all three teaching approaches targeted in the curricula in both provinces: the theoretical, the frequentist or experimental, and the subjective approaches, but focused more on the latter two.

Context of New Brunswick

In New Brunswick, francophone schools have been going through several educational reforms since 1990 (Freiman & Lirette-Pitre, 2007; Landry, 2011; Freiman et al., 2012) with the goal to improve teaching and learning for all students in an inclusive classroom context (Porter & AuCoin, 2012). In mathematics, the new curricula have been gradually implemented since 2000 at all levels (M-12) while emphasizing problem-solving, mathematical communication and reasoning, as well as the ability to make links between different branches of mathematics, mathematics and other subjects, and mathematics and real life situations. It is within this wave of reform that probability and statistics emerged and formed one branch of study (MENB, 2005). This domain is thus relatively new for early grades in school, and teachers may not have been trained to teach it. Besides the shortage of specific mathematical knowledge of the domain, being in a francophone minority setting also means a lack of appropriate resources for teachers and students (Freiman, 2010).

In order to support teachers and students, some local virtual resources have been developed to enhance the ICT integration in the curriculum as a transdisciplinary competence and in a variety of school subjects since 1994. They were further enhanced with professional development opportunities offered by the APTICA Association (Avancement pédagogique des TIC en Atlantique, www.aptica.ca) since 2000. Some schools also received individual laptops for each student (Rioux, 2012; Freiman et al., 2011). Since 2007, every teacher in the province owns an individual laptop provided by the Department of Education. In mathematics, there is an online problem solving community named CASMI (Communauté d'apprentissages scientifiques et mathématiques interactifs; see, Freiman et Lirette-Pitre, 2009), which emphasizes an ongoing collaboration between the Faculty of Education at the University of Moncton and local schools in order to support the development of teachers (IsaBelle et Savoie, 2006).

A group of 18 volunteering teachers from middle schools (grades 6 to 8) were recruited to learn about the probability simulators and learning and assessment situations related to them. Two rounds of workshops were conducted with them by one of the authors. The first round was conducted prior to the testing of the virtual tool, while the second was held after. Each workshop was given to a group of 2 to 6 teachers at the time, for a total of 4 groups with each session lasting for four hours. After the first round, teachers were asked to try the virtual tool themselves or with their students for about a month, and then invited to share their experiences during the second round.

The first impressions and perceptions of the participants regarding the possible use of these tools were collected during the second round of workshops. The responses were given during small group discussions in which teachers were asked questions related to: their experience with the simulators (what did you do with the simulator?); their opinions about the simulators themselves (what did you think about the simulation tools?); the potential of the tools in and out of the classroom setting (what could these simulators do to your teaching practice for the concept of probability?); and the future needs of resources and support in techno-pedagogy (what would you suggest about the continuation of this project?). Those questions helped identify their concerns in regards to the virtual simulators and the learning situations. The discussions were audio-recorded and analyzed by the researchers. Using teachers' answers, we identified the milieus associated with their concerns, such as their particular needs in terms of teaching the concept of probability. Then, we associated these milieus with the components of a culturally responsive teaching framework (Gay, 2000). We did not have predetermined categories in mind as we wanted categories to emerge from the data. In this kind of study on innovative practices, the analysis started as soon as data were collected, since the inductive analysis focused on what was emerging from the data (Guillemette & Luckerhoff, 2009). This methodology enabled us to identify a few emerging themes that we associated with each particular milieu which, according to DeBlois (2006) is what the participants directed their attention to.

RESULTS

In this section, we present the results from the interviews conducted during the second workshop following the exploration and experimentation of the simulators by the 18 participants. In line with our research question about the New Brunswick teachers' concerns regarding the virtual simulators and learning situations, the emerging themes were grouped into three milieus: pertinence to teaching and learning; the quality of the technological and pedagogical (didactical) design; and future development (needs in form of resources and training).

First milieu: Curriculum alignment

The first milieu identified by the teachers is related to their institutional responsibility, that is, the alignment of the virtual tool with the curriculum. The teachers agreed that the virtual simulators and the pedagogical scenarios created in line with the Quebec mathematics curriculum were pertinent to the New Brunswick context, but with minor modifications. The tools could help students create links among different subject areas and also between different branches (domains) in mathematics. The teachers' concerns were mainly related to the use of the virtual tools in supporting students to develop their mathematical competencies and about the cross-curricular competencies – both envisioned by the provincial curriculum. Beyond the learning outcomes specific to the mathematics curriculum, teachers said that the simulators could help students develop their critical thinking toward games of chance and gambling, which according to them, is an important aspect of cross-curricular learning. The resources concerning virtual simulations enabled students to gain a sense of probability scenarios without engaging in actual gambling. Figure 2 presents the Lottery 6/49 home page, where students were asked to play and test some ideas.

FIGURE 2. *Lottery 6/49 home page*

The context presented permits students to "realize the weak probability to win, but also to makes a link with buying lottery tickets" as mentioned by a teacher. Her colleague supported the statement by adding that the experiences gained from the activities helped "make youths sensitive to casino, to realize that this is a dream, to promote prevention and [create] awareness in early ages about addiction [problems] of their family and relatives." One of the teachers mentioned, "some of them [referring to family members of some of her students] are losing money."

Second milieu: support for students' learning

The second milieu identified by the teachers refers to students' opportunities to learn probability using the virtual tool. In mentioning that the material presented is good for teaching probability ("nice tool!" exclaimed one teacher, "nice way to work with!" – said his colleague), the teachers said that the options that these tools offer could allow for further use ("gives me tools to go further"). Another teacher said: "this is the first time that I see pedagogical options, a simulator that permits to change the parameters [number of trials, number of dice, etc.] in an interactive way and thus observe the effects of the changes on the frequencies". Furthermore, one teacher was sensitive to the kind of questions that were asked on *Netmaths* prior to the experimentation with virtual simulators. Those questions allowed students to go deeper and guided them to reflect more on the concepts of probability and chance.

Among others, a teacher spoke about his previous experience with the *Netmaths* website for order of operation techniques with his students. By seeing how the tool could support learning visually, he stated his surprise that a simple simulation of a game of chance could also raise questions in his students' minds regarding the observed phenomenon. For example, he said, "the simulator puts us on a questioning path (in the example of the Monty Hall dilemma), we maintained our reasoning (1/2 probability to win), but it showed something else, bringing us to question the phenomenon (2/3 as the probability to win)."

According to this teacher, a debate can be initiated to try to give meaning to the obtained results: "that obligated me [the teacher] to engage in high-level questioning and [it would] help beginning teachers to have a resource to start with." The tools can help novice teachers because they propose concrete scenarios [local fair] accompanied by plenty of good questions to ask their students: "beginning teachers start with a quality tool, and they can act like experienced teachers."

The experimental approach supported by this virtual resource allowed access to a higher level of understanding and thus, "to accelerate the students' comprehensive [learning] process", as stated by one of the teachers.

The simulators led to a more profound didactical discussion according to the participants. The analysis of the simulators allowed teachers to compare between teaching with and without computers. They mainly spoke about the issues related to representing sample space using combinatory trees in the context of Lottery 6/49, but they also discussed the possibilities to illustrate sample space in the context of playing with two dice. However, there are still limits when it comes to counting all the possibilities depending on the context. The technology can therefore be useful in helping to overcome these limits.

When the teachers noted the attractive and the dynamic nature of the virtual resource, they expressed their unanimous view that it could have an impact on students' interest. Some observed that their students' motivation increased when they used these virtual simulators compared to the same type of activity (probabilistic experiments) in a physical environment. They liked the fact that students also received feedback on their answers from the virtual tool. They believed that students' initial interest in learning probability could be further enhanced with the introduction of a simulator.

According to the teachers, the website *Fête foraine* was well-built. The design was attractive and it gave many possibilities to do mathematics in different ways. Some comments received were: "Doing mathematics differently;" and "This tool [*Netmaths*] will serve many people and for a long time."

One teacher said that no other tool was available before that permitted a large number of trials in such a short period of time. The teacher was already using simulators for games of chance with software designed for SmartBoards (white interactive board) that also included applications for probabilities. Figure 3 presents the Lottery 6/49 simulator, where students can select various simulations (the maximum number of trials is 10,000).

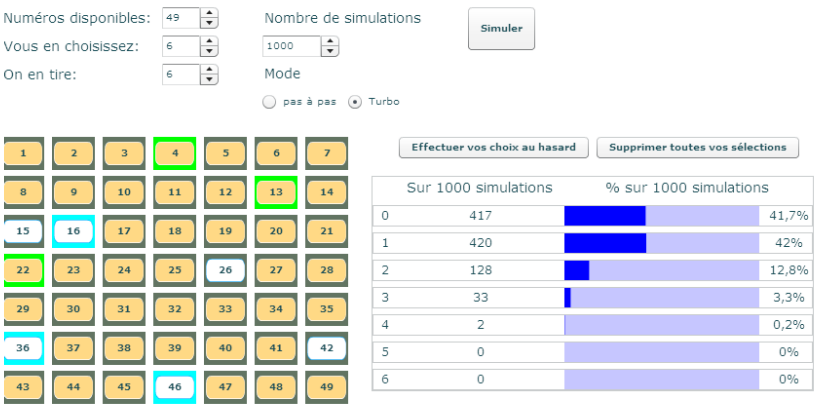

FIGURE 3. *Simulators of lottery game 6/49*

According to another teacher, school districts are expected to obtain and make available the most recent software that can support the use of websites (for example, *Flash*) and to make regular updates to the software.

This guide was very helpful according to another teacher who liked to have supporting documents to further understand the use of the virtual tools. According to the teacher, "the present guide is "short, precise, well done, high quality."

Third milieu: Teachers' needs (resources and training)

The teachers expressed their need to address students' misconceptions about probability by using the simulators. Some suggested that in the designed space of the local fair, there should have been a section that anticipated possible feedback for the students, with an answer and explanation. "Add formative and summative evaluations, pick some elements to be assessed according to our needs [website, effective tools]," mentioned one teacher. Another teacher stated that such an evaluation tool could allow him to focus on other essential elements of his work. As he explained, "I hate marking, this is frustrating for me. I want a tool that marks students." The teachers would have also liked to explore other real life contexts involving chance such as, different card games (e.g., poker) or other examples, such as the probability of precipitation (weather cast). They also said that they would like to have a bank of resources where they could find various problems on probability. Figure 4 presents some questions students are asked about their personal conceptions of probability:

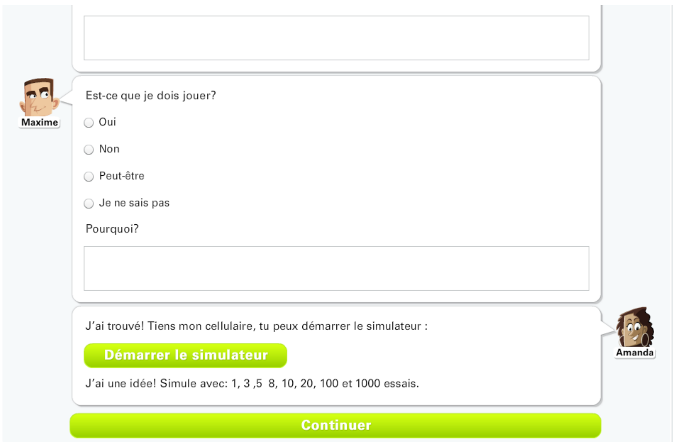

FIGURE 4. *Should I play? Students' personal conceptions about probability*[*]

NOTE. *The translation is as follow: Maxime, a character asked: "Should I play?" Students must select their answer between yes, no, maybe, or I don't know, and then provide an explanation for why they responded in the way they did. Amanda, another character, responded: "I found it! Take my cell phone and start the simulator". There is a large green button, "Start the simulator" below her sentence. Then, she said: "I have an idea, try with 1, 3, 5, 8, 10, 20, 100 and 1000 trials". A large green button "Continue" is below.*

One teacher suggested the construction of similar sites dealing with other domains of mathematics: geometry, relations, etc., and the possibility of using other virtual resources like *Sesamath* (http://www.sesamath.net) and *Math en poche* (http://mathenpoche.sesamath.net).

Another teacher suggested the need for resources to help with specific needs that could be accessed from home, such as video clips: "A lot of resources in English, but quite few in French ([eg., on] You Tube) – We could create our own video clips," as he shared. According to this teacher, videos are important for all subject areas to help teachers who are not trained as generalists. He would like video clips that could better model things for students rather than him doing demonstrations in class (sciences). He admitted that having funds available would be an important factor in developing videos and other technologies by saying that "teachers can create resources if they are let go."

DISCUSSION AND CONCLUSION

The findings from this pilot study allowed us to identify three milieus teachers were more sensitive to: curriculum alignment, support for students' learning of probability, and their techno-pedagogical needs. All these milieus showed a common characteristic: the virtual tool was a valuable resource to support the work of teachers and their students' learning.

In the first milieu, teachers demonstrated sensitivity toward the pertinence of the content in the simulators for purposes of teaching and learning probability. From a pragmatic point of view, the fact that teachers wanted to be assured that the proposed concepts correspond with those prescribed by the provincial mathematics curricula is not surprising. The language of the mathematics curriculum in New Brunswick has shifted from prescriptive to "desired" learning outcomes, without mentioning explicitly how to achieve them and what resources should be used to accomplish these outcomes. There is also a system of provincial assessments used in Grades 3, 5, 8, and 11, implemented by the Department of Education to monitor students' achievement (Freiman et al., 2012), therefore, many teachers feel 'accountable' for meeting high expectations. This milieu shows the multidimensional aspect of their culturally responsive teaching concerns.

This vision regarding the use of technology was challenged by Hedberg (2006) who believed that "disrupting innovation" emphasizes the role of technology to "enable student engagement, motivation and higher-order thinking" (Hedberg, 2006, p. 2). In this respect, our data revealed that some teachers were also sensitive to cross-curricular learning possibilities, like the development of critical thinking about games of chance and gambling and toward the development of a responsible citizen. In our previous work on implementation of interdisciplinary teaching and learning scenarios with individual laptops (Freiman et al., 2011), we also mentioned the benefits of using this approach with technology to support meaningful learning. The virtual tool was useful in fulfilling the institutional objectives that resonated with the teachers' objectives.

The second milieu was related to the contribution of the virtual tools in the teaching and learning process. From the teaching perspective, they offered options that allowed users to change various parameters during the experimentation. They also allowed the teachers to delve more deeply into probabilistic concepts by generating greater numbers of trials or by generating other cases, a finding that corroborates with previous studies we referred to earlier in our paper (Bill & Gayton, 2010; Hernandez et al., 2010). For example, students would be able to confront probabilistic knowledge through experimentation, or to question the obtained results like the ones from the Monty Hall paradox.

The tools could help teachers deepen their own knowledge of probability, thus helping novice teachers gain a better understanding of math concepts sooner in their careers. From the students' learning point of view, this tool could accelerate the understanding process. It could motivate students by giving them the opportunity to do mathematics using other methods, a finding also supported by our previous results (Freiman et al., 2011). Here again, the tools could facilitate the teachers' work by providing different approaches to teaching. It not only affected the practice of teachers in this study, but also the nature of their work. This milieu shows the empowering aspect of their culturally responsive teaching concerns.

Related to the third milieu, we noticed some of the teachers' concerns about better learning with simulators. Some participants expressed their need to know how to address students' misconceptions by using the simulators, how to provide feedback to students, or how to assess them. One teacher even highlighted the fact that he disliked doing paper-and-pencil marking of students' work, and he hoped that these tools could perform that task. Similar remarks were made by teachers interviewed on our *Communauté d'apprentissages multidisciplinaires interactifs* (CASMI) project (Freiman & Lirette-Pitre, 2009) who said that because students received individual feedback, it helped them to improve their problem solving skills. However, as shown by LeBlanc and Freiman (2011), this does not mean that this kind of feedback would go beyond pointing at students' mistakes, thus pushing them forward. This need of a "feed-forward" feedback remains an issue for further research.

Teachers wanted to approach the teaching of probability and other topics with different real life situations through a bank of available problems and resources, including other mathematical websites. This finding refers to studies of the potential of technological infrastructure to elicit modeling activities analyzed by Kaput, Hegedus, and Lesh (2007). From the pedagogical point of view, teachers expressed the need to use French language videos created by teachers themselves in all disciplines, to help those whose initial training was not in the specific discipline and to facilitate their work during classroom demonstrations. Virtual learning communities already established by researchers (Freiman & Lirette-Pitre, 2009; Jones & Simons, 1999; Pallascio, 2003; Renninger & Shumar, 2002) may have the potential to become professional learning communities. These tools are seen as a palliative element not only in professional practice, but also as a useful element for creation. This milieu shows the multidimensional aspect of their culturally responsive teaching concerns.

There are some limitations of the study. The questions that we asked the teachers might have an influence on the milieus they are sensitive to. The questions might have driven their attention to certain aspects of the tools. However, what they said goes beyond the main aspect of learning probability, because their concerns were related to general impacts on students, such as critical thinking toward gambling activities. Our workshops also focused mainly on testing and validating tools by the teachers, and no data about teachers' real use of the resource were collected within this study.

Following this analysis, our results seem to indicate that the tools developed by our team, in collaboration with teachers to support their expressed needs, have the potential to, and could rapidly, become a widely disseminated resource for a great majority of teaching professionals. However, our exploratory study raised some new questions pertaining to the implementation of digital technologies for didactical purposes. Some of these questions are:

- How can these resources be adapted to other contexts in order to maximize their impact on students' learning?
- What types of techno-pedagogical and didactical supports are needed to increase these innovative practices?
- How can the development of new techno-pedagogical resources be pursued in mathematics and in other subject areas?

These questions will allow us to deepen our data analysis in this research project and to undertake new ones.

NOTES

1. This website is available at http://www.netmaths.net in French. We used this French website for the project. However, a little cousin exist in English: http://www.buzzmath.com .
2. The Hall problem refers to a popular American television game show *Let's Make a Deal*, hosted originally by Monty Hall. The problem was originally posed in a letter by Steve Selvin to *Parade* magazine's "Ask Marilyn." The problem goes as follows, suppose you're on a game show on television, and you're given the choice of three doors: Behind one door is a car; behind the others, goats (or some non-prize). You pick a door, say No. 1, and the host,Monty Hall, who knows what's behind the doors, opens another door, say No. 3, which has a goat. He then says to you, 'Do you want to pick door No. 2 or stay with your initial choice? Is it to your advantage to switch your choice? (Mlodinow, 2008).

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REFERENCES

Batanero, C., Godino, J. D., & Cañizares, M. J. (2005). Simulation as a tool to train pre-service school teachers. In J. Addler (Ed.), *Proceedings of ICMI First African Regional Conference* [CD]. Retrieved from International Commission on Mathematical Instruction website: http://www.ugr.es/~batanero/ARTICULOS/CMIRCr.pdf

Bill, A., & Gayton, P. (2010). *Coin-sequences and coin-combinations taught as companion tasks.* Paper presented at the 8th International Conference on Statistical Education: Towards an Evidence-Based Society (ICOTS 8), Ljubljana, SI. Retrieved from https://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_C152_BILL.pdf

Bjarnadóttir, K. (2008). *Mathematics teacher knowledge in Iceland : historical and contemporary perspective*. Retrieved from http://skemman.is/en/item/view/1946/7778

Borovcnik, M., & Peard, R. (1996). Probability. In A. J. Bishop, K. Clements, C. Keitel, J. Kilpatrick & C. Laborde (Eds.), *International handbook of mathematical education* (Vol. 2, pp. 239-287). Dordrecht, NL: Kluwer Academic Publishers.

Briand, J. (2005). Une expérience statistique et une première approche des lois du hasard au lycée par une confrontation avec une machine simple. *Recherches en didactique des mathématiques, 25*(2), 247-281.

Caron, F. (2004). *Splendeurs et misères de l'enseignement des probabilités au primaire*. Actes du colloque du Groupe des didacticiens des mathématiques du Québec 2002, Université du Québec à Trois-Rivières, Trois-Rivières, QC.

Cormier, M. (2005). *La pédagogie en milieu minoritaire francophone: une recension des écrits*. Retrieved from Fédération canadienne des enseignantes et des enseignants/ Institut canadien de recherche sur les minorités linguistiques website: http://www.ctf-fce.ca/Documents/Resources/Francaise/pmm/Recension.pdf

DeBlois, L. (2006). Influence des interprétations des productions des élèves sur les stratégies d'intervention en classe de mathématique. *Educational Studies in Mathematics, 62*(3), 307-309.

Ferland, F. (2005). Efficacité d'un programme de prévention des habitudes de jeu chez les jeunes : résultats de l'évaluation pilote. *L'encéphale*, *31*(4), 427-436 .

Freiman, V. (2010). Complexité de la formation initiale des enseignants en mathématiques au primaire en milieu francophone minoritaire : le cas du Nouveau-Brunswick. In J. Proulx and L. Gattuson (Eds.), *Formation des enseignants en mathématiques : tendances et perspectives actuelles* (pp. 201-214). Sherbrooke, QC : Éditions du CRP.

Freiman, V., Beauchamp, J., Blain, S., Lirette-Pitre, N., & Fournier, H. (2011). Problem-based scenarios with laptops: An effective combination for cross-curricular learning in mathematics, science and language. *World Journal of Educational Technology*, *3*(3), 136-152.

Freiman, V., & Lirette-Pitre, N. (2007). PISA 2000. Case Study: New Brunswick. In Arbeitsgruppe Internationale Vergleichstudie (Ed.), *Schullleistungen unde Steurung des Schulsystems im Bundesstaat: Kanada und Deutschland im Vergleich* (pp. 336-362). Muenster, DE: Waxmann.

Freiman, V., & Lirette-Pitre, N. (2009). *Building a virtual learning community of problem solvers: Example of CASMI community*. *ZDM – The International Journal in Mathematics Education*, *41*(1-2), 245-256.

Freiman, V., Richard, P., & Jarvis, D. (2012). *Enseignement de mathématiques au N.-B. (secteur francophone).* In J.-L. Dorier & S. Coutat (Eds.), *Enseignement des mathématiques et contrat social* : enjeux et défis pour le 21e siècle – Actes du colloque EMF2012 (SPE3, pp. 1761-1780). Retrieved from http://www.emf2012.unige.ch/images/stories/pdf/Actes-EMF2012/Actes-EMF2012-SPE3/SPE3-pdf/EMF2012SPE3FREIMAN.pdf

Garofalo, J., Drier, H.S., Harper, S., Timmerman, M.A., & Shockey, T. (2000). Promoting appropriate uses of technology in mathematics teacher preparation. *Contemporary Issues in Technology and Teacher Education* [Online serial] *1*(1). Retrieved from: http://www.citejournal.org/vol1/iss1/currentissues/mathematics/article1.htm

Gay, G. (2000). *Culturally responsive teaching: Theory, research, and practice*. New York, NY: Teachers College Press.

Godino, J. D., Cañizares, M. J., & Díaz, C. (2003, August). *Teaching probability to pre-service primary school teachers through simulation.* Paper presented at the 54th Session of the International Statistical Institute, Berlin, DE. Paper retrieved from http://www.stat.auckland.ac.nz/~iase/publications/3/2989.pdf

Grenon, V., & Larose, F. (2006). L'informatique scolaire chez les enseignants du primaire: une ressource additionnelle ou un dispositif pédagogique alternatif. In J. Lebrun, J. Bédard, A. Hasni, & V. Grenon (Eds.), *Le matériel didactique et pédagogique : soutien à l'appropriation ou déterminant de l'intervention éducative* (pp. 327-352). Québec, QC : Les presses de l'Université Laval.

Guillemette, F., & Luckerhoff, J. (2009). L'induction en méthodologie de la théorisation enracinée (MTE). *Recherches qualitatives*, *28*(2), 4-21.

Hedberg J.G. (2006, August). *Searching for disruptive pedagogies: Matching pedagogies to technologies*. Keynote address at the Curriculum Corporation 13th National Conference, Adelaide, AU. Retrieved from http://cmslive.curriculum.edu.au/verve/_resources/Hedberg_Paper.pdf

Hernandez, H. Kataoka, V., & de Oliveira, M. (2010). *Random walks in teaching probability at the high school*. Paper presented at the 8th International Conference on Statistical Education: Towards an Evidence-Based Society (ICOTS 8), Ljubljana, SI. Address retrieved from https://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_2B1_HERNANDEZ.pdf

Hugues, M., & Daykin, N. (2001). Towards constructivism: Investigating students' perceptions and learning as a result of using an online environment. *Innovations in Education and Teaching International*, *39*(3), 217-224.

IsaBelle, C., & Savoie, R. (2006). Développement professionnel avec les TIC in situ pour les futurs enseignants. *Revue des sciences de l'Éducation*, *32*(1), 133-157.

Jonassen, D.H. (2007). A taxonomy of meaningful learning. *Educational Technology*, *47*(5). 30-35.

Jones, K. & Simons, H. (1999). *Online mathematics enrichment: An evaluation of the NRICH project*. Southampton, UK: University of Southampton.

Jonnaert, P., & Vander Borght, C. (1999). *Créer des conditions d'apprentissage : un cadre de référence socioconstructiviste pour une formation didactique des enseignants*. Paris, FR: De Boeck

Kaput, J., Hegedus, S., & Lesh, R. (2007). Technology becoming infrastructural in mathematics education. In R. Lesh, E. Hamilton & J. Kaput (Eds.), *Foundations for the future in mathematics education* (pp. 173-192). Mahwah, NJ: Lawrence Erlbaum Associates.

Konold, C., & Kazak, S. (2008). Reconnecting data and chance. *Technology Innovations in Statistics Education*, *2*(1), 1-37. Retrieved from http://escholarship.org/uc/item/38p7c94v#page-1

Landry, L. (2010). L'enseignement des mathématiques au Nouveau-Brunswick francophone : vers la réussite scolaire et des apprentissages durables pour tous les élèves. In V. Freiman, A. Roy & L. Theis (Eds.) *Acte de colloque du Groupe des Didacticiens des Mathématiques du Québec (GDM) : L'enseignement des mathématiques dans et à travers des contextes particuliers : quel support didactique privilégier ?* (pp. 12-20). Retrieved from http://turing.scedu.umontreal.ca/gdm/documents/ActesGDM2010.pdf

Larose, F., Bourque, J., & Freiman, V. (2010). The effect of contextualising probability education on differentiating the concepts of luck, chance, and probabilities among middle and high school pupils in Quebec. In C. Reading (Ed.), *Data and context in statistics education: Towards an evidence-based society. Proceedings of the Eighth International Conference on Teaching Statistics*. Retrieved from The Netherlands: International Statistics Institute website: http://www.stat.auckland.ac.nz/~iase/publications/icots8/ICOTS8_C133_LAROSE.pdf

Larose, F., Grenon, V., Lenoir, Y., & Desbiens, J.-F. (2007). Le rapport des futurs enseignants à l'utilisation de l'informatique pédagogique : Fondements et trajectoire longitudinale. In B. Charlier & D. Peraya (Eds.), *Transformation des regards sur la recherche en technologie de l'éducation* (pp. 171-188). Bruxelles, BE: De Boeck.

Larose, F., Palm, S., Grenon, V. Hasni, A. & Lessard, Y. (2005). Le rapport des élèves du secondaire aux jeux électroniques ainsi qu'à l'usage scolaire de logiciels ludo-éducatifs. *Revue suisse des sciences de l'éducation*, *27*(3), 467-488.

LeBlanc, M. & Freiman, V. (2011). Mathematical and didactical enrichment for pre-service teachers: mentoring online problem solving in the CASMI project. *The Montana Mathematics Enthusiast*, *8*(1–2), 291-318.

Martin, I., Gupta, R., & Deverensky, J. (2007). Participation aux jeux de hasard et d'argent. In G. Dubé and others (Eds.), *Enquête québécoise sur le tabac, l'alcool, la drogue et le jeu chez les élèves du secondaire, 2006* (pp. 125-144). Retrieved from Institut de la statistique du Québec website: http://www.stat.gouv.qc.ca/publications/sante/pdf2007/Tabac_Alcool2006.pdf

Martinovic, D., Freiman, V., & Karadag, Z. (Eds., 2013). *Visual Mathematics and Cyberlearning. Mathematics Education in Digital Era (Vol. 1.).* Dordrecht, NE: Springer.

Ministère de l'Éducation du Nouveau-Brunswick (MENB) (2005). *Programme d'études en mathématiques. 5e année*. Fredericton, NB, Canada. Gouvernement du NB. Retrieved from http://www.gnb.ca/0000/publications/servped/Mathematiques5eAnnee.pdf

Mlodinow, L. (2008). *The drunkard's walk : How randomness rules our lives*. Toronto, Ont, Canada: Random House in Canada Ltd.

Munisamy, S., & Doraisamy, L. (1998). Levels of understanding of probability concept among secondary school pupils. *International Journal of Mathematical Education in Science and Technology, 29*(1), 39-45.

O'Shea, T., Scanlon, E., Hennessy, S., Twigger, D., Byard, M., Driver, R., ... O'Malley, C. (1993). Twenty-nine children, five computers and a teacher. In D. Edwards, E. Scanlon R. West (Eds.), *Science education: Teaching, learning and assessment*. London, UK: Paul Chapman Publishing.

Pallascio, R. (2003). L'Agora de Pythagore: une communauté virtuelle philosophique sur les mathématiques. In A. Taurisson & A. Senteni (Eds.), *Pédagogies.net : l'essor des communautés virtuelles d'apprentissages* (pp. 193-210). Québec, QC: Presses de l'Université du Québec.

Porter, D., & AuCoin, A. (2012). *Strengthening inclusion, strengthening schools. Report for the review of inclusive education programs and practices in New Brunswick schools: An action plan for growth.* Fredericton, NB: Government of New Brunswick.

Renninger, K.A., & Shumar, W. (2002). Community building with and for teachers: The Math Forum as a resource for teacher professional development. In K.A. Renninger & W. Shumar (Eds.), *Building virtual communities: Learning and change in cyberspace* (pp. 60-95). New York, NY: Cambridge University Press.

Rioux, M. (2012). *Évolution des projets de formation de futurs enseignants au primaire au contact de situations probabilistes* (Unpublished doctoral dissertation). Université de Montréal, Montréal, QC.

Savard, A. (2008). *Le développement d'une pensée critique envers les jeux de hasard et d'argent par l'enseignement des probabilités à l'école primaire: Vers une prise de décision*. Unpublished manuscript, Université Laval, Québec, QC.

Savard, A. (in press). Developing probabilistic thinking: What about people's conceptions? In E. Chernoff & B. Sriraman, *Probabilistic Thinking: Presenting Plural Perspectives* (Vol. 2). New York, NY: Springer.

Savoie-Zajc, L. (2004). La recherche qualitative/interprétative en éducation: étapes et approches. In T. Karsenti & L. Savoie-Zajc (Eds), *Introduction à la recherche en éducation* (pp. 109-121). Sherbrooke, QC: Éditions du CRP.

Scanlon, E., O'Shea, T., Smith, R.B., & Li, Y. (1997, December). Supporting the distributed symdromous learning of probability: learning from and experiment. In R. Hall, N. Miyake & N. Enyedy (Eds). *Proceedings of the 2nd international conference on Computer support for collaborative learning* (CSCL '97) (pp. 227-233.). Retrieved from http://dl.acm.org/citation.cfm?id=1599801

Seal, K. C., & Przasnisky, Z. H. (2005). Illustrating probability through roulette: A spreadsheet simulation model. *Spreadsheets in Education, 2*(1), 73-94. Retrieved from http://epublications.bond.edu.au/cgi/viewcontent.cgi?article=1028&context=ejsie

Theis, L. & Savard, A. (2010, July). *Linking Probability to Real-World Situations: How do Teachers Make Use of the Mathematical Potential os Simulation Programs?* Paper presented at the 8th International Conference on Statistical Education: Towards an Evidence-Based Society (ICOTS 8), Ljubljana, SI.

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