THE IMPACT OF USING PUPILS' DAILY SOCIAL PRACTICES AS WELL AS COMPUTERIZED SIMULATORS AS A TEACHING MEDIUM ON MOTIVATION AND KNOWLEDGE CONSTRUCTION REGARDING PROBABILITIES AMONG HIGH SCHOOL PUPILS

Vincent Grenon[1], François Larose[1], Jimmy Bourque[2] and Johanne Bédard[1]
[1]University of Sherbrooke, Canada
[2]University of Moncton, Canada
vincent.grenon@usherbrooke.ca

Probability education, from a purely mathematical and decontextualized point of view, notably regarding frequency-based probabilities, leaves barely any evidence of long-term learning among middle school pupils. When contextualized in a playful manner, and by calling on pupils' daily social practices, probability education becomes a powerful tool for giving meaning to statistics in a school setting. Within the framework of a funded research conducted among high school pupils in 8 classes with 5 different participating teachers in the Montreal region, we integrated the use of computer games to teach probabilities. In this paper, we will summarize survey results and results of group interviews conducted with these pupils at the end of the study. Our research data show that learning while playing, by using computerized simulators as a teaching medium, is effective in motivating pupils and in building knowledge.

INTRODUCTION

The study of probabilities generally only occupies a marginal space in programs for the teaching of mathematics in high school in industrialized countries (Konold & Higgins, 2003). Teachers are generally little or poorly prepared. The types of learning activities proposed are generally stereotyped, bringing the concept of probability to the notion of calculating the relative frequency of occurrence of an event. Teaching is only rarely based on the exploitation of authentic situations, which does not foster generalization and transfer, and leaves the field open for development of attitudes or erroneous reasoning manifested in daily life situations affecting school success and the daily practices of pupils (Musch & Ehrenberg, 2002). The construction of specific competencies in probabilistic reasoning, notably during adolescence in populations "at risk" represents a major stake in their capacity to manage, in an effective and rational way, their behaviours concerning their consumption of gambling games.

A major hiatus exists between the linearity of teaching and naive theories which base the representations of pupils and teachers on chance constitutes one of the principal difficulties in the learning of probabilities in the school context (Sedlmeier, 2000). Under these conditions, it appears to us that teaching based on the exploitation of authentic situations may imply the realization of learning at the cognitive level. However, if authentic situations are not strongly associated with the social practices of the pupil, there will be no or little transfer towards other domains of learning or effect on attitudes and social behaviours, notably in the recourse to gambling games (Lecoutre, Clément & Lecoutre, 2004).

Taking into consideration the initial representations of pupils with respect to random phenomena as well as the controllability of chance in the teaching of these notions affect the development of a realistic attitude in this regard. In summary, recourse to active methods, using realistic learning contexts, founded on the knowledge of practices of references of pupils, sustain well the learning of mathematics in general, and of probabilities in particular. Recourse to active methods also applies to the use of technologies as a medium to sustain the learning of mathematics and probabilities (Brokaw & Merz, 2004; Sedlmeier, 2000).

In this study we propose to investigate the recourse to active methods of teaching, using realistic contexts based on the knowledge that pupils have of gambling games. And to do this, we shall construct learning situations integrating computerized simulators that will sustain their motivation while learning probabilities.

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METHOD

This collaborative research has been underway for almost two years. The research team is composed of university researchers, professors in the didactics of mathematics and 5 participating high school teachers specialized in the field of mathematics.

In order to investigate the recourse to active methods of teaching, using realistic contexts based on the knowledge of reference of pupils on gambling games, we proceeded in three phases. In the first phase, we built, validated, and administered a survey by questionnaire. This questionnaire enabled us to document the principal sociological characteristics of the family environment of pupils, their practices of recourse to electronic games, as well as their profile in use of gambling games. Concomitantly, and during the second phase, we developed computerized gambling simulators in conjunction with "*NETMATH*" (a team involved in the development of a Website for the acquisition of competencies in pupils by supplying them with drill exercises, simulators, mathematical explanations, etc. In keeping with the Quebec Mathematics Program they support 315 schools, 15000 teachers and 55000 young subscribers). In the third phase, these simulators, used on laptops placed at the disposal of pupils, represented an innovative context of learning and experimentation, closely associated with authentic teaching and learning situations constructed by the research team and participating teachers following the administration of the questionnaire in the first phase.

The convenience sample consisted of pupils in the first cycle of high school (mean age: 13.77, SD: 0.72) from a low socioeconomic background under the responsibility of the 5 participating teachers (8 groups of pupils) who accepted to participate in this study. The survey by questionnaire enabled us to collect responses from 265 pupils (52.5% boys, 47.5% girls).

In the current research design, we propose to deploy a virtual environment simulating diverse situations such as those offered in online casinos or in poker rooms found on the Internet. These simulations were associated with the highly contextualized situations of learning and evaluation on the notions of probabilities associating the authentic with the documented impact of serious games in school contexts (Squire, DeVane & Durga, 2008). The experimental phase took place between the months of March and April of 2009 as part of the regular class activities.

Following the experimentation phase, we proceeded with a series of group interviews of one hour with a subsample of pupils from each of the participating classes. These interviews concerned current practices on the use of gambling games; their representation on how they learn mathematics, and the impact on education received through recourse to simulators. Of the 265 participants at the outset, a total of 35 pupils, 18 girls and 17 boys were interviewed. Transcripts of the semi-structured interviews were treated through a lexicometrical approach inspired by Lebart, Salem and Berry (1998). This type of textual data analysis enables us, from a contingency table crossing the frequency of the use of words by individuals, to distinguish those used most frequently–these are the stable concepts denoting a common interest among the group, compared to those used less frequently–these words are of marginal nature because of a lack of common interest.

RESULTS

Questionnaire results enabled us to document the consumption practices of gambling games, as well as the representations of pupils regarding the importance of chance in these types of games. The 10 items relative to their frequency of consumption of gambling games are shown in table 1 (in percentages).

This profile of consumption of gambling games is associated to the gender of pupils. We observe an overweighting of boys having more frequent recourse to draw poker (Likelihood ratio = 46.244 (6), $p < 0.001$; Cramer's V = 0.396, $p < 0.001$) as well as stud poker (Likelihood ratio = 23.853 (5), $p < 0.001$; Cramer's V = 0.290, $p < 0.001$). To a lesser degree, boys are equally more inclined to resort to other types of online lotteries (Likelihood ratio = 23.242 (6), $p = 0.001$; Cramer's V = 0.271, $p = 0.004$). For most items, the frequency of recourse by girls is inferior to that of boys.

Table 1. Items relative to the consumption of gambling games

	Frequency of consumption (in percentages)						
Item	Never	Once a year	Two to three times a year	Once a month	Two to three times a month	Once a week	Nearly every day
Draw poker	54.8	12.9	14.1	7.6	6.8	2.7	1.1
Stud Poker	70.6	11.1	8.8	4.2	4.6	0.8	----
Instant lotteries (scratch)	73.4	13.7	7.6	4.6	0.8	----	----
Weekly lotteries	91.2	6.2	1.9	----	0.4	0.4	----
Other free online lotteries	82.0	9.6	6.5	0.8	----	1.0	----
Online casino (requires downloading)	85.4	5.7	3.1	1.5	1.5	1.5	1.1
Online casino (without downloading)	84.3	6.1	4.6	1.5	2.7	0.4	0.4
Video poker	93.5	3.8	1.9	0.4	----	0.4	----
Other online lotteries	85.3	7.3	3.5	0.8	1.5	0.8	0.8
Bingo	45.2	27.0	16.7	8.0	1.5	0.8	0.8

The perceived importance of chance associated with different gambling games was of importance to us during the conception of teaching and learning situations and served as a guide for the creation of simulators. Table 2 presents the perceived importance of chance in the different games presented on a six point Likert scale.

Table 2. Perceived importance of chance in different gambling games

	Level of importance (in percentages)					
Items	Less important	…	…	…	…	More important
Draw poker	21.1	12.6	24.8	23.2	8.1	10.2
Stud poker	23.9	16.0	25.9	18.1	8.2	7.8
Instant lotteries (scratch)	20.6	7.3	8.9	10.5	11.7	41.1
Weekly lotteries	21.8	6.0	5.6	8.1	11.3	47.2
Other free online lotteries	21.8	8.5	17.7	15.7	15.3	21.0
Online casino games	24.3	10.1	13.0	16.6	16.6	19.4
Video poker	27.0	11.3	12.9	15.7	16.9	16.1
Other online lotteries	27.2	13.2	10.0	13.6	12.8	23.2
Bingo	17.4	9.9	16.2	17.0	11.9	27.7

The perceived importance of chance is not associated to gender except in the case of weekly lotteries for which boys generally underestimate the part played by chance in this type of game (Likelihood ratio = 19.132 (5), $p = 0.002$; Cramer's V = 0.271, $p = 0.03$).

A summary of results from the lexicometrical analysis of group interviews that took place at the end of the experiment is shown in table 3. The elements retained stem from recurrent words and word segments that were stable and most frequently used by pupils during the interviews as determined by the lexicometrical analysis of each question.

Table 3. Summary of lexicometrical analysis results

Interview themes	Principal elements shared in the discourse of pupils
Gambling games (betting with money)	The fact of betting with money is fun, interesting and stimulating. The possibility of winning money is what makes gambling games appealing.
Representations on how they learn mathematics	Mathematics are difficult, requiring logic, effort and understanding.
Appreciation of computerized simulators	The fact of seeing the simulations on the screen helped many pupils understand the notion of probability better. All pupils agree that placing these activities on the Internet would enable them to learn better. They also agreed that participating in these activities was motivating and helped them learn better.

DISCUSSION

The results of table 1 show that despite the legal age required (18 years old) to engage in gambling games, the proportion of pupils is higher than would be expected, considering the average age of pupils in our sample. The overweighting of poker games for boys/males is consistent with findings in the scientific literature (Will Shead, Hodgins & Scharf, 2008). Even though pupils identified well the part played by chance in instant and weekly lotteries in table 2, they had a tendency to underestimate the part played by chance in the other games, as in online casino. Following the collection of data, we are in a position to state that the group interviews provided us with interesting elements on the usefulness of computerized simulators as a teaching tool to motivate pupils and for building knowledge of probabilities. It is important to mention that the joint development of teaching and learning situations based on the knowledge of reference of pupils on gambling games in collaboration with university researchers, professors in the didactics of mathematics, and the 5 participating high school teachers, contributed towards the success of the project. Although the results are encouraging at this stage, the study has limitations and further research is required since data regarding knowledge construction about probabilities are mostly representational. In order to compensate for these limitations, a tool to assess the competencies of pupils in the learning of probabilities will be administered to pupils completing the study in March, 2010. Ideally, an experimental design (controlling for external variables with an experimental and a control group) would help us better understand the impact of these teaching and learning situations combined with the use of computerized simulators to develop in high school pupils the learning of probabilities.

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