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Stemming from an interest in developing suitable didactical activities to prevent gambling abuse during the school years, this paper explores the use of an Android app that simulates the outcomes of a famous Italian instant lottery. Some features that characterise the phenomenon of gambling abuse are sketchily recalled, the Android app is presented and an example from classroom activities is discussed. We conclude that the simulator support probabilistic thinking and understanding of models about gambling, as traditional random generators do, and also exploits emotional reactions, such as shock, which allow curiosity to emerge and pave the road towards deeper understanding.

Why do we care about school place learning when dealing with gambling abuse? A first, general argument is: the persistent expansion of gambling has its roots in mathematical illiteracy. Contucci (2012) underlines that the expenditure in gambling decreases with the increase of scientific culture and concludes that mathematic education is a key factor for the risk of gambling abuse. Not only knowledge, but also beliefs about gambling play a role: Bastiani *et al.* (2011) observe a relationship between beliefs and behaviour, in that the students who disapprove gambling also play less. Nonetheless, newspapers, TV programs, radio news, and media in general contribute to develop misconceptions about gambling. Information, messages, advertising that concern gambling induce people to believe that gambling represents a genuine opportunity to "change one's life" and to become rich. Media report biased information about gambling, where only the (rare) cases of win are advertised, and no room is given to talk about risks of systematic gambling (among all, the risk to become pathological gamblers). In doing so, media contribute to create the illusion, especially within the less skilled part of the society, that it is easy to win (see also Capitanucci, 2012). Young students, specifically, are prone to think that studying and working hard are not as necessary as trying the luck in gambling in order to shape their own future. School as an institution takes a major role in developing and sustaining awareness about this mistaken view of life (Capitanucci, 2012).

The second argument is grounded on the observation that gambling is an increasing phenomenon among young people. In Italy, Serpelloni (2013) has estimated that 1.720.000 people are gamblers at risk to become pathological, and 708.225 ones are pathological gamblers. Moreover, 11% of them are under-18 years old people. If we look at the students population, 47% of students between 15- and 19-years-old are gamblers. Few years before, also Molinaro (2009) has observed that 40% of Italian high school students (45.000 young people aged between 15 and 19 years) declare to have bet at least once during the year 2008. Gambling abuse is typically considered as the first step towards pathological gambling and school years represent an important period of life in which it can be possible to prevent the spreading of such addictions. Gamblers are pathological when they spend much more money and much more time than the money/time they would have liked to spend on gambling activities. Pathological gambling is an illness that has been recognised by the Organisation Mondiale de la Santé (OMS) since 1980. Studies in psychology of addiction (e.g.,

Capitanucci, 2012) have demonstrated that pathological gamblers live a rupture between two "worlds": the world of betting games, practices, experiences, and the world of telling, thinking and reasoning about such games. If the latter could be embodied by school place (and mathematics learned therein), there is a challenge for researchers in mathematics education: that is, could there be a way to implement learning activities at school that can have some effect on gambling practices, and specifically that can prevent gambling abuse?

The phenomenon of gambling abuse is complex and involves psychological, social, relational, cognitive variables. One of the behaviours that is at its core, however, regards the gamblers' inability to stop gambling: roughly speaking, after a win, since some money is earned, a gambler does not leave the game because she wants to earn even more money; on the other hand, after a loss, a gambler does not leave the game because she wants to recover the money she has lost. Given the very low probability of getting significant prizes and the unfairness of gambling games, usually gamblers do not stop betting and loose more and more money. In this respect, mathematical arguments and models can provide a better understanding of the experience of loss enlighten by the above considerations. A need clearly emerges: the need to teach those "tools" of mathematics that can be useful to understand the frequent stories of systematic losses experienced by gamblers.

The research project BetOnMath (http://betonmath.polimi.it) promotes learning activities that focus on gambling and originate from real experiences of gamblers. It aims at preventing gambling abuse, hence it cannot be understood as a "therapy" for pathological gamblers, but as a "vaccine" for young students in general. The "vaccine" consists in learning activities, which shed light on the mathematical models of random situations that characterise gambling. Mathematical teachers propose these activities during the school time, following the general structure proposed by Roth and Radford (2011), namely: (1) the students are exposed to a real situation in which they have to solve a problem resorting to their everyday concepts; (2) in small groups, mainly of 4/5 members, the students discuss and propose a solution to the problem, while the teacher in turn interacts with each group; (3) a general discussion follows and the outcomes of each group are collected, compared, generalised. As regards the opportunity (and necessity) for the students to be exposed to a real situation, also Siller and Maaß (2012) underline that the topic of probability taught for understanding gambling "is a very authentic one, so that the students have the possibility to discuss a real-life problem which could be found in their near environment" (p. 65), and the context prompts the students to "use mathematics as a decision support" (p. 65, Siller & Maaß, 2012).

Back to the challenge stated at the beginning of this paper, our research stems from the following hypothesis: if at school it is possible to simulate gambling activities, practices, emotional responses to the outcomes, then teachers can have a chance to play a social role in preventing gambling abuse. The learning trajectory can be conceived as a 3-phases activity: in the first phase the students simulate real gambling activities (points (1) and (2) in the aforementioned structure proposed by Roth and Radford); in the second phase students share experiences of loss and start to make sense of them; in the third phase they "mathematise" the phenomenon (second and third phases correspond to point (3)). In this paper, we focus on the first phase and present an example of a couple of students dealing with a simulator of an instant lottery (based on a random generator). We elaborate on the role of technology in activities of this sort. To this end, we discuss the role of knowledge, experiences, emotions, perceptions, body movements, intuitions, relations with other students and with artefacts.

The simulator and its theoretical background

The simulator is a random generator that simulates the outcomes of an instant lottery that is very famous in Italy. Considering the emission of 30.000.000 tickets, Table 1 reports the prizes and the number of corresponding winning tickets for each prize.

The probability of getting a prize with the simulator is the same as in the real game, with most of the tickets with no prize (61.5%), many tickets winning small prizes, such as 5 euro (28.7%) or 10 euro (6.8%), and fewer and fewer tickets winning the higher prices, up to 500000 euro (0.0000167%). Two interesting mathematical activities can be carried out: one that enhances the awareness of the very low probability to win a prize that is higher than the price of the ticket, and one that enhances the awareness that the more one plays, the more she looses. In fact, the price of each ticket is 5 euros, but the average prize is about 3.50 euros. This paper is concerned with the second kind of activity. The simulator allows the students to simulate the outcomes of large numbers of scratches of the instant lottery, and to visualise them on a graph reporting the money spent (i.e., a straight line with slope 5) and the money earned in term of prizes (i.e., a random curve "around" a straight line with slope 3.5). Since the students interact with the simulator before any mathematical content regarding gambling has been introduced, they come to deal with data first, and then with the mathematical model.

Prize (in euro)	Number of tickets
500.000	5
100.000	25
10.000	250
1.000	5.000
500	7.500
100	65.000
50	120.000
25	90.000
20	270.000
15	350.000
10	2.030.000
5	8.610.000

Table 1: the number of winning tickets from an emission of 30.000.000 tickets.

Our didactical approach is based on exploratory data analysis (EDA), introduced by Tukey (1972). This approach places emphasis on looking at data sets in order to form hypotheses worth testing, instead of putting forward hypotheses concerning the possible kind of probability model that the data follows. For example, in our context we interpret EDA as firstly handling (many) simulations of a phenomenon, then looking for similarities among the different outcomes, and finally trying to find out a mathematical explanation for these similarities. EDA, therefore, allows the data to unfold an underlying structure and suggest admissible models that best fit. EDA working principle consists in looking at the data, valuing: i) graphical displays, ii) numerical summaries, and iii) the natural pattern-recognition capabilities that people possess.

We see a learning potential for this perspective, which frames our research activity, in contrast to the modelling perspective on distribution, which accounts for unexplained variation as random movement away from the main effect (e.g., the mean value). In the modelling perspective, data distributions are seen as variations from the ideal model, the variations being the result of "noise" randomly affecting the "signal", as reflected in the model itself (Prodromou, 2008; Prodromou & Pratt, 2006). In our approach, instead, the focus is exactly on the variations that simulated data produce.

Eichler and Vogel (2014) observe that computer-based simulations support students in building a model where irrelevant features are disregarded, and the mathematical phenomenon is condensed in time and available to the students' work. Thus, formal mathematics could be reduced to a minimum, allowing students to explore underlying concepts and to experiment with varying setups. Simulations are at the same time physical and algorithmic models of reality since they allow an intuitive work on the relevant model that facilitates later mathematical formalisation (Batanero *et al.*, 2005).

Our instant-lottery simulator has been implemented as an Android app (using the MIT app inventor platform http://ai2.appinventor.mit.edu). Availability and surprise are two reasons for developing a simulator suitable for smartphones: on the one hand, in fact, smartphones are, among all the technological devices, those which are more commonly used by the students for communication and leisure activities (hence, on average, in each class there are at least 5-6 smartphones that can be used for group activities, one smartphone per group); on the other hand, the fact that the use of personal smartphones in classes is allowed is an element of surprise for Italian students, which can enhance creativity, thinking, intuitions. The "a priori" considerations found a confirmation in our extensive classroom observation during the first phase of activities carried out on April-June 2014: all 23 secondary school classes that have been monitored have carried out activities based on the use of the instant-lottery simulator, relying on easily available smartphones and exploiting feelings of surprise.

(A) **(B)**

Figure 1: the instant-lottery simulator. In (A), "Gratta e Perdi" means "Scratch and loose", "Gratta un biglietto" reads "Scratch 1 ticket", and "Gratta N biglietti" reads "Scratch N tickets". Where it is written "Gratta Qui" in light grey, the students have to scratch with their finger, and a prize (or no prize) can be found. At the bottom, "Totale spesa" reports the total amount paid for buying the tickets, which corresponds

to the red line in (B), “Totale premi” reports the total amount of prizes earned and corresponds to the green line in (B), and “Differenza” is the net balance of the game.

The app has a very simple structure and is extremely easy to use, so that it does not even require any introduction to have the students starting to play. In the main screen (depicted in Figure 1A) two playing options are available, "Scratch 1 ticket" and "Scratch N tickets". Selecting the first option, the user can scratch a single ticket and discover the prize (if any) just moving the finger on the smartphone display. Hence, the instant-lottery simulator looks like the real one in two fundamental aspects of the game: (1) the probability of getting each prize is the same in both situations, and (2) the students have to scratch in order to find out the prize. This similarity allows us to recreate, in classroom, a situation that is similar to the real one: emotions, tensions, actions and decisions that emerge in the simulated acts of scratches very well resemble the ones carried out by actual gamblers, as experts of gambling addiction noticed while looking at videotaped student activities during intensive analyses carried out together with us. However, distinguishing elements from the real game have been introduced in the app, in order to stimulate thinking and foster learning: (1) the messages for “no prize” and “you win 5 euros” have been modified to “you have already lost 5 euros” and “you win 5 euros, but you have already spent them in order to buy the ticket”, respectively; (2) at the bottom of the page, there is a summary of money virtually spent for the tickets (red), the sum of the obtained prizes (green), and the difference between prizes and expenses (blue), which represents the net balance of the game. Once the ticket is scratched, the summary at the bottom of the screen is updated.

In our research hypotheses, the “Scracth 1 ticket” activity allows the students to experience the very low probability to get a high prize. Hence, they experience the very *high probability of loosing* their money. The “Scratch N tickets”, indeed, allows the students to experience what happens when a large number of tickets is bought. Hence, they experience *the certainty to loose* more and more money as they play more and more times.

In order to allow the user to experience what happens when a large number of tickets is bought, the "Scratch N ticket" option allows to select the number of tickets and to graphically visualise the results. As the ticket counter evolves, a straight red line (whose slope represents the constant cost of each ticket) is drawn together with a less predictable green curve representing the total amount of prizes that have been found (Figure 1B). The random nature of this second curve is much more evident when a small number of tickets is considered. Indeed, for very large number of tickets the curve tends to stabilise around a second straight line whose slope represents the average prize (3.5 euro), which is obviously smaller than the ticket price.

Claudio and Luigi

We now present an excerpt that has been selected from a videotaped lesson taking place in a grade-12 class on May 2014. This is part of an extensive classroom observation carried out on May 2014, which allowed us to get more than 20 hours of videotaped lessons. The excerpt resembles some common dynamics that we have observed. Two students, Claudio and Luigi, are working in pair with Luigi’s Android smartphone. At a certain point, a student from another group joins the activity, then he left after a while. His name is Giorgio. After having installed the app on his Android smartphone, Claudio has just opened the instant-lottery simulator, and he is doing first experiments. Luigi seats beside him, watching him. The 2-minutes excerpt under analysis begins with Claudio clicking on “Scratch 1 ticket”. With his finger he virtually scratches the ticket, he observes the outcome and he clicks again on “Scratch 1 ticket”. In the first 23 seconds he scratches 7 tickets: only the first one has a prize, and we can see exultance in Claudio’s reaction:

00:02 C: Yeah! I have won!

Claudio is concentrated on the game, making repeatedly the same sequence of gestures: clicking, scratching, clicking, scratching, and so on. Claudio's posture tells that he is completely focused on the simulator: his back is curved, his harms are embracing the simulator, his head is fix. The only part of his body that moves is his left hand (Figure 2A).

(A) (B)

Figure 2: Claudio's posture in his relationship with the instant-lottery simulator.

We can see the student as passive in receiving the outcome of the instant lottery, and his reactions are passive emotional reactions to the outcome. Apart from the first ticket (exultance), his emotional reactions reveal a tension, a desire to get a winning ticket. We can see this tension embodied in Claudio's posture: he is motionless, being all his body statically expecting to get the next win. This expectation, this tension is the motive of Claudio's repeated actions of clicking and scratching. At 00:14 Claudio's classmate, Giorgio, asks:

00:14 G: Can you stop?

00:15 C: [*shaking his head*] No, I can't stop

This short interaction takes place during Claudio's repeated sequence of gestures. An external observer, as Giorgio is, is stuck by Claudio's involvement about the instant-lottery, and he invites him to stop. But Claudio is impervious to Giorgio's invitation. At 00:23 Claudio notices something, and he stops scratching for a while:

00:23 C: Ah! Here it is said how much I have lost.

There is a change in his emotional reaction: from exultance to disillusion. We perceive this in the tone of his voice, and also his posture changes: his back is less curved, and his harms no longer embrace the simulator (Figure 2B). Taking advantage of Claudio's stop, Luigi takes the role of clicking and scratching:

00:23 L: If I play, I win.

Luigi is very confident in his luck. From 00:23 to 00:32 Luigi clicks and scratches 3 times, he does not win, and Claudio comments:

00:25 C: The next time, I will win. Sure (Figure 3A)

00:27 L: No, the next time I will win!

In 00:25 and 00:27 we have underlined the words that correspond to an increase in the tone of voice.

Luigi's act results as an invitation to Claudio to stop thinking about "how much he has lost", and to keep scratching. This is exactly what happens, and now also Luigi's posture reveals that he is engaged, too (Figure 3B).

(A) (B) (C)

Figure 3: Also Luigi is engaged in the game.

At 00:35 Luigi glances away from Claudio, and Claudio is again alone with the simulator. He touches Luigi's arm, to involve him (Figure 3C). Claudio get a prize: 5 euros.

00:39 C: I have won!

00:40 L: This is how we can make Claudio happy

Luigi glances away again, but also the new ticket has a prize. Claudio looks at Luigi and says:

00:43 C: Other 5 euros!

Hence, Luigi is again involved. At this point of the activity, they decide to click on the button "scratch N tickets", and they fix N=100. The simulator takes 37 seconds (from 00:50 to 01:27) to scratch 100 tickets, the students are observing the outcomes and commenting on them:

00:53 C: Look! Look: I am winning! (Figure 4A)

00:55 C: We have found a prize of 1000 euros. Do you see? When it does like this (Figure 4B)

01:08 L: [*both students have remained silent for a while*] What a bore! We are winning nothing.

01:12 C: Nooo, we have won a squat…

01:15 L: Bbb, we won nothing

01:16 C: [*echoes with a gesture* (Figure 4C)]

01:18 L: We have lost, how much? 300, more than 300 euros.

01:21 C: Uh! (Figure 4D) [*looks at the teacher*] We were over the red line. (Figure 4E)

01:24 L: [*staring at the simulator*] We have won! (Figure 4F)

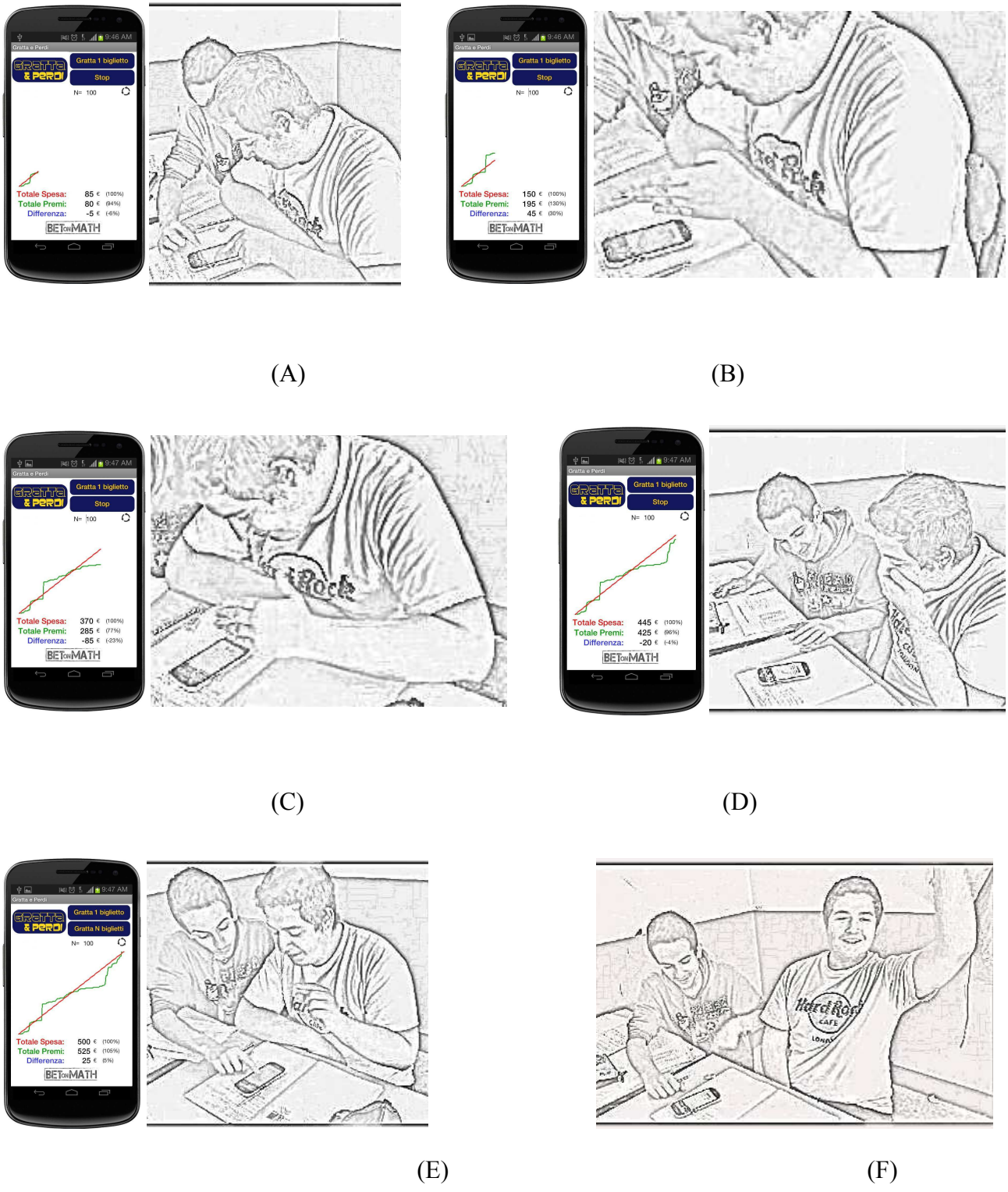


Figure 4: Claudio and Luigi simulate 100 replications and they end up winning.

At 00:55 Claudio observes a sharp increase, he mimics the steepness of the graph with his hand (Figure 4B), and says: we have won 1000 euros. Claudio has exaggerated the prize, which was just 100 euros: we can notice that in 100 scratches one pays 500 euros, hence it not possible to get a prize of 1000 euros and loose 300 euros at the end of the same simulation (as said in Luigi's comment at 01:18).

At 01:21 (figure 4D) and at 01:24 (figure 4F) the two students have found two different prizes: the first one makes the situation change, from being "below the red line" (losing) to being "above the red line" (winning, namely the difference between the money paid to play and the prizes earned is

positive); the second one sets them definitively as winners. This is a rare event, it is much more common to end up with a losing situation, namely: the amount paid to play the game is more than the prizes earned. Thus, the students call the teacher: this uncommon outcome is worth to be noticed by her. This is really typical in gambling situations: only stories of winning are told.

In the sequel, the students make other simulations, clicking N=100, N=300, N=1000 tickets all at once. In all these repeated simulations, they loose their money. Then, they decide to click N=50 tickets (the reader can notice that the smaller the number of simulation, the greater the variance, hence with 50 tickets there is a higher probability to end the simulation as a winner). At the very start, a winning ticket comes out, but then they keep not winning and Luigi comments:

05:41 L: Shit! We should have stopped at the 25th trial.

This is also noticed by Claudio:

05:47 C: Here we were at zero, right?

From that moment, they loose money in buying tickets rather than earning money with prizes. But, one second later, something happens:

05:48 C: Yes! (Figure 5A)

05:49 L: Prof… we have won AGAIN!

05:50 C: Prof, we have won!

05:51 L: We have won!

Called by her students, the teacher approaches, and both Claudio and Luigi are eager to tell her their story, a story of winners:

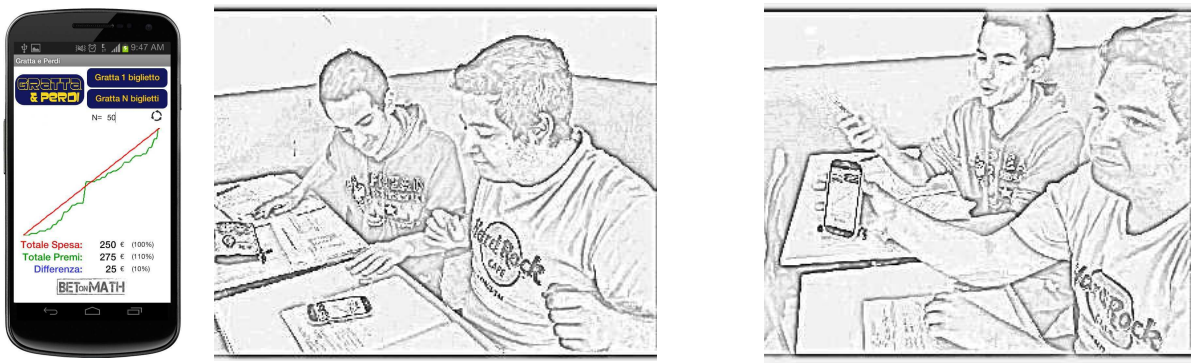
05:57 L: We have lost at 25…ehm, we have won 25 euros, but we have won. (Figure 5B)

06:02 T: Oh my god! This smartphone is rigged!

Since the students tend to notice and remember only the times they win, the simulator has a "secret button", which opens another page that reveals the total amount of money that the students have paid, the amount they have earned (with prizes), and the (negative) difference between earned money and price paid (Figure 5C-5D) since when the app has been installed on the smartphone. At this point of the activity, the teacher clicks on this button and the new page tells a completely different story: a (true) story of losers, not an (illusory) story of winners!

Looking at Figure 5B, we can notice that Claudio is looking at the teacher confidently, and proud of his "luck". Luigi is exulting and telling her what has happened. Right after the teacher had clicked on the "secret button", in Figure 5C Luigi stares intensively at the screen, trying to figure out what do numbers tell, and in Figure 5D he is having an "AHA" experience: he understands that, in all, they have spent more money than they have won.

In the sequel of the activity, the teacher would collect and report on the blackboard the experiences lived by her students, and mathematical modeling would arise. However, this falls outside the focus of the paper, hence we now present a discussion about the use of such an instant-lottery simulator, and its implications.



(A) (B)

(C) (D)

Figure 5: from a story of winners to a story of losers.

Discussion of the excerpt

In the introduction to this paper, we have claimed that the activity with the instant-lottery simulator can contribute to bridge the dramatic gap between the world of betting games, practices, experiences, and the world of telling, thinking and reasoning about such games. This claim has a theoretical foundation and empirical evidence that will be discussed in the following.

The device

As theoretical foundation, we recall that virtual random generators support students' understanding of probabilistic models: the phenomenon is condensed in time, formal mathematics is reduced to a minimum, and intuitive sense-making processes facilitate later mathematical formalisation (Eichler & Vogel, 2014). At the beginning of the excerpt, for example, Claudio and Luigi experience the low probability of winning by scratching single tickets. This is mirrored by their repetitive utterances that focus on their lost, and the belief that they will win in the near future ("The next time, I will win"). The frequentist approach to probability allows to focus on empirical data and fosters the emergence of mathematical models as a need to understand patterns that seem significant. The students, in fact, firstly scratch N tickets and no theory is needed: they notice that it is more frequent that the green line is below the red one (namely, that they loose money). In comparison with a simulation that, under the classical approach to probability, allows the students to explore a model that already exists, we believe that a simulation that prompts them to develop an unknown model in an incremental way is much less artificial. Not only: it is also engaging, because the students do not already know the mathematical model, hence they see the challenge of "winning". The empirical character of the problem situation, in a simulation based on the frequentist approach, indicates that data is needed (Wild and Pfannkuch, 1999) before reliable hypothesising is possible. In fact, in this

activity it is not possible to carry out any reasoning before data are shown: only later in the activity, the students will try to figure out why they systematically loose money. In this way, mathematical models will have a central role only after experiences have been made.

Empirical evidence resides in the short example that is paradigmatic of some interesting dynamics, which had taken place during our extensive classroom observations. In the excerpt presented in this paper, the activity with the simulator activates sensibilities to notice, to access mathematical generalisation. The instant-lottery simulator, in fact, activates touch and sight, as well as touch and sight activate the use of the device. At the beginning of the excerpt, for example, it is Claudio's touch that is activated by the device: the device says "Scratch here", clearly inviting him to touch it. Conversely, Claudio's touch activates the device. Also sight is activated by the device: Claudio can read the outcome, and at a certain point his sight captures a detail that is important ("here it is said how much I have lost" at 00:23), and this modifies Claudio's perception of the device (we see him detached for a while).

Perception is, according to the construct of sensuous cognition (Radford, 2013), the substratum of mind and it is culturally shaped. Perception is a sensing form of action and reflection, which can lead to culturally-historically forms of mathematical generalization. Touch and sight in relation with the simulator, thus, pave the road to emotional reactions and deep reflections about the phenomenon. This is achieved when it emerges the need to give sense to an experience of loss, which comes out through a shock. At the end of the excerpt, in fact, the students are confident and proud of their luck ("we have won again!" at 05:49). But, when the teacher reveal the "secret page", Luigi realises that they have lost a lot of money: his facial expression in figure 5D yields us, thus, calling it a shock.

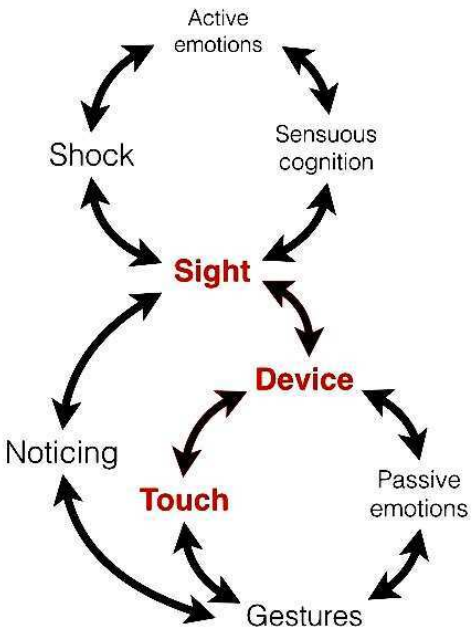


Figure 6: a diagram to summarise the main ideas of this work.

The diagram in figure 6 shows the main ideas that we are discussing in this paper: the *device* activates (as well as it is activated by) *touch* and *sight*, but this is not enough to prompt sensuous cognition in full. If only touch plays an active role and sight serves the purpose of just seeing what the finger should go, the student lives a passive experience similar to the one of real gamblers: he acts on the device, he makes *gestures* that mimic the outcomes of the simulations, but only *passive emotional reactions* take place. And it is not enough that sight starts to play a central role and allows

the students' sensibility to *notice* that a lot of money is being lost (as it happens at 00:23 for Claudio). An emotional and cognitive *shock* is necessary for the students to become active: active thinkers with *emotions* that sustain their learning and provide the *motives* for the learning activity to go on. It is only after the shock that *sensuous cognition* can emerges in its full potentiality: not only as the feature of living material bodies that have responsive sensations (Radford, 2013), but as an unavoidable union of mind and body, emotion and knowledge, which allows the learner to deeply understand both *the phenomenon* of systematic loss *and himself* as a gambler.

Having clarified the two-ways relationship within the elements of the diagram of figure 6, in the sequel we dwell further on each element, to highlight and discuss specific themes.

Touch

As regards touch, we draw on Sinclair and de Freitas' (2014) observation that there is a significant conceptual traffic between gesture and touch. The nature of this traffic is related to the particular media in question. In our case, the device activates touch, and touch activates gestures (scratch, click). And gestures activate touch. Sinclair and de Freitas (2014) underline that traditional studies on gestures tend to divorce the *motoric finger* (gesture) from the *feeling finger* (touch). We consider gesture and touch in terms of the material effects they achieve, and we see an unavoidable relationship between the two: for example, consider the repeated act of clicking and scratching that Claudio is doing at the beginning. Immediacy is clearly one of the keywords that can describe the situation: there is no mediation between the act of clicking on "Scratch 1 ticket", the feeling of the finger when scratching the surface, and his going back to the button to be clicked. This absence of mediation is both physical and mental. Physical mediation is missing, since the finger actions are directly related to changes on the screen (rather than being indirectly related in mouse manipulation in previous screen culture norms): the finger actions have a direct or relatively unmediated impact on the given surface. Mental mediation is also missing, since Claudio does not need to think about what is doing. This is mirrored also in his reaction to Giorgio's prompt on stopping to scratch, in that he "cannot stop": no mediating reflection on the finger action is fostered, as far as only touch is involved.

Gesture

Looking at Figure 2A, we notice that the only part of Claudio's body that moves is his left hand. To comment on this feature, let us recall McNeil's understanding of *gesture space* (McNeil, 1992). McNeil divides the space pertaining the body of a person in terms of a centre and a periphery. The centre corresponds to the abdomen and shoulder, the periphery to the head, the arms, and the legs. In Claudio's case only the left hand is moving, and according to McNeil we could say that Claudio's gestures regard the periphery. Claudio's steady and fixed posture is central. The actual outcome of the simulator is very central, as we can see from Claudio's posture and his unrelenting gazing to it. The act of scratching with his finger is, indeed, peripheral: it just serves the purpose of unfolding the outcome. Later in the activity, there are both: (1) gestures that involve the whole body of Claudio, and (2) gestures made only with the hand that are very central. Type 2 gestures require a deeper understanding of peripheral and central features, going beyond McNeil's taxonomy.

As regards type 1 gestures, in Figure 4D there is an element of surprise: the green line is above the red one, and this involves Claudio's body as a whole. This is also mirrored by his utterance: "*we* were above the red line". It is not just the green line, the same students are above the red line. In Figure 4F, exultance involves all Claudio's body, since exultance for a winning outcome is central to this activity. As regards type 2 gestures, let us analyse Figures 4A-C and E. In Figure 4A, Claudio is only pointing at the screen, only his left hand is involved, but his words tell that what he is *pointing at* is all but peripheral: "Look: I am winning". First person speech reveals that he is

actually living this experience intensely. Figures 4B, 4C and 4D show mimicking gestures: in Figure 4B Claudio's gesture mimics the steepness of the random green curve when they get a high prize, the gesture in Figure 4C mimics the opposite, namely a series of loosing outcomes, and the gesture in Figure 4D represents an interval, namely the distance between the red and the green curves. The first gesture, in Figure 4B, helps him stressing the importance of what he is saying in words: "We have found a prize of 1000 euros. Do you see? When it does like this". Moreover, the tone of Claudio's voice, his emotional involvement and the use of such a sharp gesture yield us to conclude that this is central to Claudio's understanding of what is going on, even if the gesture is performed with a peripheral hand. Moreover, his exaggerating the win (as we have commented, they have won much less than 1000 euros) speaks to his deep engagement. The second gesture, in Figure 4C, substitutes the speech: Claudio is, in fact, replying to Luigi's utterance in this way. As in Figure 4B, this gesture is central in his interaction with his classmate and with the artefact, so central that it replaces words. The third gesture, in Figure 4E, seems to be redundant to speech, but we see it as a clue that the student as a whole, both mind and body, is involved.

Sight, noticing and shock

At a certain point, sight comes to play a central role: it stops to serve only the purpose of seeing where fingers should go on the screen in order to get the desired outcome (i.e., seeing where the button is, in order to get a new ticket, or seeing where to scratch in order to get a prize). Sight activates noticing. Noticing is, according to Mason (2011) a potentially intentional act. To notice requires *attention* to *something*, hence noticing requires both observation *and* the object under observation (Mason, 2011). Furthermore, noticing intertwines with attention, consciousness and awareness.

A first sudden and intense emotion is felt by Claudio when he notices that "here it is said how much I have lost": this is rather a shock, in the sense that he lives for the first time an experience of loss, instead on focusing only on his wins. It is his sight, which catches the bottom of the page, that allows him to notice and activates his sensibility. Not only: this has an effect on his practice, since for a while he stops scratching. Before this act of sight, emotions are frozen in a tension to keep clicking and scratching. Sight activates noticing, noticing activates emotional response.

The major shock comes at the end of the excerpt, when the students are shown that in few minutes they have (virtually) spent more than 15.000 euros and (virtually) lost more than 5.000 euros. Again through sight, Luigi grasps the sense of the numbers on the page, and intense emotions accompany this moment of sudden revelation. This experience changes their attitude towards the simulator, and they stop using it. The illusion of winning has disappeared: we can claim that they are seeing the game with new eyes.

Emotions: active and passive

In the excerpt, Claudio lives different emotions: he is involved, enthusiastic, captured by the simulator, then he is detached for a while. Cognitive elements appear first as belief that he is going to win for sure, and this belief is strictly intertwined with emotions of involvement and pleasure. He enjoys the activity, both with his body and with his mind. Gestures mimic what is happening on the screen, exultance is pervasive of all his posture. He is self-confident when he calls the attention of his teacher, and he experiences intense frustration when facing the "secret page". Roth and Radford (2011) see emotions as the engine that provides the motive for the activity to go on. In the learning process, emotions are not a trait-like feature of the subject, but they constitute a holistic expression of the subject's current state with respect to the object and the subject's *sense of likelihood of* success. Emotions can provide the learner with a sense of likelihood of success and enhance his actions, or they can provide him with a sense of likelihood of failure, and impede his actions. With

Roth and Radford (2011), we see that emotions mediate the movement of the activity itself, they accelerate the pace of compulsively clicking-and-scratching, as well as they provide motives to stop and reflect. But, we observe that the students are passive to the act of receiving the outcomes of the simulator, and we refer to them as *emotional passive reactions*. The presence of these passive reactions requires to go beyond Roth and Radford's understanding of emotions, by incorporating the role of active and passive emotions.

The activity with the instant-lottery simulator needs to create a passive situation, in order to resemble what actually happens to gamblers in real games. This is different from having an emotional sense of likelihood of failure: on the contrary, Claudio has an emotional sense of success, he is truly believing that he will win, even if his emotions are passive. Sure, his emotions enhance the scratching activity, but at the same time they impede thinking. This situation is different from the ones taken into account by Roth and Radford, because the artefact that mediates the activity is different: the instant-lottery simulator is designed to create passive emotional reactions instead of active thinking situations.

Is there a moment in which the students can become active? If we look at Figure 2B, we see that Claudio has already noticed that, at the bottom of the page, it is said "how much I have lost". In this moment, we have an emotional reaction as well, but at the same time this provides a move away from the game, a motivation to stop and think, to become an active thinker. This is also the first time in the activity that sight stops to serve the purpose of just seeing where fingers should go, and noticing is activated.

However, some seconds later, the students are again involved in the game and passively responding emotionally to the outcomes. To stop gambling is much more difficult than to keep gambling. The app resembles quite well this aspect of the phenomenon taking place in real life. Hence, it provides an experience the students can reflect upon, later. Why later? Because when the game is taking place they are impervious to any kind of reflection upon what is going on. Emotions are, in that moment, too strong to be frozen out into thinking. In order to stop to be resistant to argumentation, a major shock is necessary.

The game is really engaging: Luigi is detached at the beginning, but when Claudio stops for a while he tries to scratch, in first person, then he moves away but cannot resist the second attempt, from Claudio, to involve him. Engagement is both active and passive: it is active, because Luigi takes the floor and scratches in first person. But it is passive, at the same time, because the students have no choice: they cannot be detached. This is an interesting feature of gambling in general: it gives the player a feeling of active choices, but at the same time gamblers cannot choose to stop, since they are engaged (Bastiani *et al.*, 2011).

Another interesting feature of gambling that emerges is that students report only winning experiences: they want to capture the teacher's attention only when they get prizes. This resembles another common feature of gambling that can induce addiction: people are prone to remember only their winning experiences, to see themselves as winners. And newspapers follow this tendency, reporting the rare cases of significant winning instead of shedding some light on the much more frequent losses and on the possible risks of gambling abuse. This phenomenon is emotionally charged: positive emotional reactions sustain the gambler's engagement, without letting him stop.

Claudio, as we have already observed, weakly detaches himself from the activity when he just *notices* "how much I have lost". We have also argued that this fact speaks to the possibility, for the students, to detach from this involving gambling activity. The possibility arises when they discover how much money is lost. We have also argued that noticing is not enough to get out from passive emotional reactions. For Luigi it is necessary a shock, a revelation: one can loose so much money in

a very short period of time. Only after the shock, the game has completely lost its appeal. In fact, the students stop betting and are open to learn why things have gone this way.

Conclusions

To summarise, the instant-lottery simulator can be seen as an example of a technological device that provokes emotional responses to gambling outcomes. Consequently, this study explores new possibilities for technological devices: that is, to foster emotional activation as integral part of cognitive understanding and generalisation. Technology (embodied in the Android app), touch, sight, emotion and cognition are indeed the keywords of this research. Not only, they are also strictly interrelated to the main ideas of this conclusion, which pivot around the experience of shock: shock is emotionally as well as cognitively charged, it is triggered by perception and changes behaviour. The diagram in figure 6 represents an attempt to summarise the main ideas that emerge in our work: the device activates perception, but if sight plays the sole role of seeing where the finger should go, the students live passive emotional reactions that very well resemble the ones experienced by actual gamblers. Even when sight allows the students' sensibility to notice, it is difficult for the learners to leave the game. It is only through a shock that the students have a chance to become active thinkers. It is in this occasion that sensuous cognition exploits its own potential.

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