

**Reflection of the mathematical dimension
of gambling in iGaming online content - A qualitative analysis:
The usage of key math terms
- Technical report no. 6 -**

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Whatever the extent to which a gambling site reflects the mathematical dimension of gambling in their informative sections, the usage of the key mathematical terms – such as odds, probability, and expected value – is necessary from both a linguistic and an informational perspective.

The current report presents results of the qualitative analysis of the usage of the key math terms in the content of the reviewed websites in the current sample, with emphasis on the necessary distinctions for the word and concept of ‘odds’.

Patterns, motivations, conceptual and contextual aspects of the usage are discussed.

The theoretical norms of adequacy of this usage in the context of gambling are briefly presented.

The report also suggests how the texts employing the key math terms with an inadequate usage can be revised for reaching a correct and relevant description of the games and gambling and for ensuring the premises of an adequate understanding of the mathematical concepts that those terms represent and their application in the real world of gambling.

Introduction

Mathematics is strongly connected to gambling through the mathematical models underlying any game of chance. Mathematics is reflected not only in games’ design/characteristics and their outcomes, but also in gamblers’ perception and knowledge of the mathematics-related facts of gambling – which influence their gambling behavior.

The math-indispensability principle (Bărboianu, 2013) applies not only in problem-gambling research, but also in the gambling industry. The structural, informative, strategic, psychological, pathological, and ethical aspects of gambling have been identified to be grounded in the mathematics of games and gambling (Griffiths, 1993; Bărboianu 2014, 2015; Turner & Hobay, 2004; Harrigan, 2009, and others).

Gambling cognitive distortions, language, and miscommunication

Gambling-specific cognitive distortions (in the form of misconceptions, misunderstandings, reasoning fallacies, biases, false or irrational beliefs, or illusions, alone or mixed) are believed to be an important cause of the development of problem gambling and are considered as major risk factors (Lambros & Delfabbro, 2007; Leonard & Williams, 2016, and others). We have analyzed these cognitive distortions in relation to the mathematical dimension of gambling and found that most of them are mathematically related (Bărboianu, 2022, pp. 219-221).

An important element that shapes and influences the aspects of gambling mentioned above, especially cognitive distortions, is language. The language of gambling can be intentionally or innocently misleading, confusing or conflicting, largely due to the mathematical nature of the essential concepts governing gambling, but also to the nature of language itself. The language of gambling unavoidably uses mathematical and mathematically-related terms and as such is a mixed language and therefore predisposed to semantic conflicts. This language may aim toward descriptions of the games, of their associated strategies, for communication between gamblers and between gamblers and experts, and to express any observations or research results in regard to this phenomenon. The fact that some specialized terms belong or are tightly related to probability theory accounts for their conflicting potential in the gambling language, since the concepts of probability theory are sensitive to interpretation, despite their mathematical nature (Bărboianu, 2022, pp. 203-218).

The problematic gambling language manifests in the activity spheres of developers, operators, gambling communities, information providers, experts (including problem-gambling experts), and gamblers' relationships with these people. This language affects the descriptions of games and gambling that the players actually use to become informed about the phenomenon; also affected are the communication between gamblers, and between gamblers and people from the gambling industry or experts as well as gamblers' own conceptual judgments related to gambling.

Goals and outcomes of the study

In this theoretical framework, research is able to derive concrete norms and criteria to adequately reflect the mathematical dimension of gambling in the communication and texts associated with the gambling industry. These norms and criteria of adequacy will be further communicated to policy and decision makers in both governmental and private sectors, with the recommendation for implementation.

Our study aims to evaluate qualitatively the reflection of the mathematical dimension of gambling in the content of gambling websites. This analysis is necessary in order to have an objective and concrete image of the actual state of this matter in the online industry and of the challenges that such research and application would face in the real world of gambling.

A minimum number of 120 gambling websites will be reviewed annually for their content in that respect. A statistical analysis will record the presence of the mathematical dimension of gambling and its forms in the content of participating websites, and a qualitative research will analyze and assess the quality of the content with respect to that dimension.

Methods and technical description of the instruments

The current study is a combination of quantitative and qualitative analysis, in which the latter is predominant and is given the central role.

The participants in the study (gambling websites, through their webmasters) were recruited through online advertising and direct invitations. Given the focus on the qualitative aspect of the study, the sample is not representative for the entire population. Besides, representativeness cannot be established with respect to the specificity of the population (gambling websites) and of the targets of the study.

The criteria of eligibility for participation that we have applied are:

- not having legally prohibited content or advertising;
- meeting the gambling legal requirements;
- having informative content besides the games and games' rules
- being fully operational and navigable.

The quantitative analysis will use basic descriptive-statistics methods, summarizing the data recorded from the sample by standard statistical indicators, with the following main specific variables:

v_1 - the presence of structural descriptions of the games in parametric terms (valued yes/no);

v_2 - the presence of informative sections ('How to' articles, blogs, guides) (valued yes/no);

v_3 - the presence of sections dedicated to odds/probability/math (valued yes/no);

v_4 - the usage of essential math terms specific to gambling (odds/probability, expectation, average/mean, etc.) (valued yes/no);

v_5 - the presence of the definitions of the math terms used (valued yes/no);

v_6 - the correctness of the math definitions used (valued on a scale from 0 to 5)

v_7 - the presence of game strategy topics (valued yes/no);

v_8 - the presence of math-based game strategy topics where applicable (using notions of probability theory, statistics, and game theory) (valued yes/no);

v_9 - the presence of systematic-learning or advanced content of gambling math (lessons, academy-style sections, in-depth guides, etc.) (valued yes/no);

v_{10} - the mentioning of author for math-related articles (valued yes/no);

v_{11} - the match between the math-related articles and their authors' declared expertise (valued on a scale from 0 to 3);

v_{12} - in-text presence of awareness on possible misconceptions, fallacies, and irrational beliefs in regard to gambling (valued yes/no);

v_{13} - the correlation of the above awareness with the mathematical aspects of gambling (valued on a scale from 0 to 3).

The values are conditional on each other as follows:

v_3, v_7, v_9 conditional on v_2 ; v_5 conditional on v_4 ; v_6 conditional on v_5 ; v_8 conditional on v_7 ;

v_{11} conditional on v_{10} ; v_{13} conditional on v_{12} .

The qualitative analysis will use as methods discourse analysis, content analysis, thematic analysis, conceptual interpretation, semantic analysis, doubt about sense, and analysis of arguments. It will have a strong component of linguistic-conceptual-logical analysis, targeting the following main elements:

- 1 - the usage of terms with non-uniform semantics;
- 2 - the contextual usage of math terms;
- 3 - the conceptual linkages relative to the relevance for the topic;
- 4 - the soundness of arguments based on applied math;
- 5 - the association between game strategy and the concepts of probability theory and game theory;
- 6 - the presence and contextual impact of “mathematically prohibited” or misleading terms (such as ‘winning strategy’, ‘how to win’, etc.).

Although the qualitative analysis is independent of the quantitative one, correlations will be made between the conclusions of the former and the variables of the latter.

Representation of the mathematical dimension of gambling may or may not be adequate in the content of gambling websites. The main goal of the qualitative analysis is to establish the disciplinary areas, as well as their individual roles, which can contribute to the theoretical framework that will derive the norms and criteria for such adequacy in the content of the websites and of the gambling communication. These disciplinary areas entitled for involvement include mathematics, psychology, linguistics, philosophy of language, epistemology, and philosophy of mathematics.

Content and roles of the technical reports

Monthly technical reports describing the partial results of the qualitative analysis will be published on academic channels, preceding the main publication at the end of the study. Each technical report will cover the review and recording of data from ten websites, which are nominated in the section titled *Appendix*, along with brief descriptions from their owners.

We found such technical reports necessary, first because the current study is atypical in what concerns the statistical analysis and the qualitative analysis, as well as the objects under investigation. Therefore, the main role of the technical reports is to detect and define any methodological and technical difficulties encountered during this study and any challenges they may pose, for them to be analyzed and surmounted in both the continuation of the current study and any future similar research.

Besides presenting these difficulties and challenges, the technical reports will also contain unpredicted observations regarding the analyzed content that might require the revision or change of the methods and instruments used.

The results of the technical reports will be gathered, and general conclusions will be drawn in the main publication.

Observations and conclusions from the review of the current sample

Obviously, the idealistic aim that gambling websites will have informative sections reflecting the mathematical dimension of gambling and providing relevant mathematical descriptions of the games and gambling, by which to ensure an adequate understanding of the concepts involved, is hard if not impossible to attain. The reasons for that were partially discussed in the previous reports and pertain to factors such as the SEO-oriented content policies and management, and in general the commercial features of such sites.

A site with systematic lessons and explanations of gambling math should be an educational-mathematical site and not necessarily a gambling one, as such content is actually a course of study. Conversely, for an educational site providing gambling-math insights as applications of math in gambling, gambling as an activity is of marginal interest and cannot be qualified as a gambling site. In conclusion, an adequate content reflecting the mathematical dimension of gambling in a gambling site should be a sort of compromise between a gambling-math course and an objective presentation of the matter for the gambler in a non-academic context.

Whatever the extent to which a gambling site reflects the mathematical dimension of gambling in their informative sections, the usage of the key mathematical terms – such as odds, probability, and expected value – is necessary from both a linguistic and an informational perspective. This necessity arises from the very natures of the text and context themselves:

The term ‘odds’ (the main term of a mathematical nature used in the gambling discourse) is crucial in describing a game of chance, as well as strategic aspects of the play, where applicable. The mathematical terms ‘probability’ and ‘expected value’ (or ‘expectation’) are employed in both the conception and the presentation of objective strategies of playing (where applicable), whose motivations and goals can be expressed only by using that term. In other words, it’s impossible to describe a game of chance and possible associated strategies without using these math terms, acknowledged as representing mathematical concepts.

But using a math term in a non-mathematical context raises many conceptual-semantic-epistemological issues, especially for terms belonging to statistics and probability theory, because these terms have to be understood by their mathematical definition, but interpreted in an empirical context where their application is not straightforward as with other mathematical notions.

In our review of the to-date sample of gambling websites, we observed the usage of the key math terms ‘odds’, ‘probability’, and ‘expected value’, and our qualitative analysis set its task from the very beginning to focus on them and their usage, as they are essential in determining the mathematical dimension of gambling.

There were no reviewed sites not using these terms, at least that of ‘odds’, as the use is unavoidable. However, sometimes it is better not to use a term than to use it inadequately or not adapted to the context.

The wide majority of the sites used the terms ‘odds’ in their informative sections describing the games, but also in articles having as topics strategic aspects, while ‘probability’ and ‘expected value’ were used preponderantly in strategy, guides, and how-to sections. It is worth nothing that there were a few sites not using at all the terms ‘probability’ and ‘expected value’; all of these sites fall within the category that focuses on offering games and having minimal informative content.

One of the main goals was to observe how these terms and concepts are defined and whether the distinctions between them are incorporated correctly in the content of the sites.

Only some of the sites offering gambling-math sections and systematic-learning content provided a mathematical definition for ‘probability’ (at least classical Laplacian probability). Many sites provided a general definition in non-math terms (such as ‘the likelihood of an event happening’ or ‘the chances for an event to happen’), which, besides being circular, do not reflect the specific nature and features of this concept and are not relevant for the context of gambling. Excepting math-oriented sites, no reviewed

gambling site employed the concept of (mathematical) measure when defining probability for their readers (probability as a measure of possibility).

Some sites used interchangeably the terms ‘odds’ and ‘probability’, while some of them avoided this kind of use, seemingly because ‘odds’ is used more as a synonym for ‘payout rate’. Only two sites out of 298 reviewed employed *and explained* the distinction between ‘odds’ as payout odds/rate and ‘odds’ as ‘probability’, which is a very important distinction. These sites provided that information in articles written by experts in gambling math.

Some sites, although they have employed the distinction in one or more sections, did not keep it across all their articles.

Another meaning for ‘odds’, that of the statistical average ‘return to player’ (RTP, as one minus house edge) was marginally used.

Overall, the sites were not consistent with the distinction between the various meanings of ‘odds’. We noticed that a few top sites (as traffic, popularity and ranking), although having gambling-math sections claimed as written by experts, did not employ the distinction in some of their articles.

The distinction was employed by the wide majority of sportsbooks, which in turn (most of them) wrongly equated the notion of ‘implied probability’ (specific for sports betting) with a type of probability, while the former is just another way to express the payout odds offered by the bookie.

Such distinctions become very important in specific contexts and topics. For instance, a few sites treated the topic ‘what games offer the best odds’, ranking the games by this criterion. However, the meaning of ‘odds’ is decisive for such rankings, which change from one meaning to another.

Another distinction that is not always incorporated is that between ‘true odds’ (as probability) and house’s odds (as payout odds). However, very few sites failed to distinguish between the two meanings.

Regarding the term ‘expected value’, most of the sites defined it in a mathematical context by adapting the notions involved in the formal mathematical definition to terms from common speech, such as ‘long run’, ‘payout’, ‘likelihood’, “average”, and so on. While such adaptation is justified, as the non-math reader is not supposed to understand the mathematical notion of mean of a random variable, most of the sites did not catch in their definition or presentation the idea of ‘statistical average’, which is determinant for the concept of expected value. Moreover, the concept of ‘long run’ represents infinity in the mathematical notion of expected value. Not stating this “forced” interpretation leads to possible misconceptions about this notion.

Overall, it was observed that the sites whose content policy is oriented toward expert information and presentation incorporated the key gambling-math terms in their content, but not all of them achieved an adequate usage of these terms, which is necessary to ensure correct understanding and to avoid misconceptions and misleading their users. Granted these are primarily gambling sites, not math or applied-math sites, as reflected in their content and metadata. We can fairly hypothesize that this condition prevents them more or less to reach an adequate and consistent usage of the gambling-math terms in their content.

But whatever the intent of the management of these sites, adequate and consistent usage of math-related terms is essential.

Adequate usage of the gambling-math terms in gambling discourse of any kind is very important, as it is responsible for preventing or correcting several misconceptions, fallacies, and false beliefs about gambling (Bărboianu, 2022). The main principles or norms of adequacy for such usage are:

- making the semantic distinctions between terms with similar form and keeping them across all the content;
- not using undefined terms – providing definitions or links to such definitions to external wiki or expert sources;
- adapting the mathematical definitions to a common non-expert language, while giving access to the mathematical definition for those interested;
- catching the main relevant distinctive features of the mathematical concept when defined in common language;
- highlighting the shortfalls of the interpretation of the mathematical concept in the real (empirical) context of gambling; not equating the formal concept with its empirical counterpart, especially in non-mathematical context.

The question arises as to how the gambling texts employing the key math terms with an inadequate usage can be revised for reaching a correct and relevant description of the games and gambling and for ensuring the premises of an adequate understanding of the mathematical concepts that those terms represent and their application in the real world of gambling. The most direct way of doing that is for a site's staff to incorporate into the site a stand-alone gambling-math knowledge section to which to refer or link from the general gambling texts. Then, the entire content must be revised with an eye on conceptual distinctions and interpretation of the math notions in the context of the articles. The support of an expert in gambling math and mathematical education is necessary if this matter does not fall within the expertise of the site's staff.

Given the importance of usage of the gambling-math terms for the current research project, it will be touched on in many aspects in the forthcoming reports.

Appendix – Selective list of reviewed websites

legalbet.ro (reviewed in May 2024)

It provides ratings for locally licensed online bookmakers and casinos from Romania, supporting players in making informed decisions by documented analysis and verified information.

legalbet.es (reviewed in May 2024)

It provides ratings for locally licensed online bookmakers and casinos from Spain, supporting players in making informed decisions by documented analysis and verified information.

canadiancasinos.ca (reviewed in June 2024)

It provides information about online casinos for players living in Canada, such as banking methods, customer service, and game variety. Each casino listing includes information about the sign-up bonus, deposit and withdrawal methods, and customer support.

worldcasinodirectory.com (reviewed in June 2024)

It covers gambling in all forms all over the world, from casinos, poker, sports, bingo, lottery and horse racing, providing detailed reviews for each venue both land based and online.

casasdeapuestasdeportivas.cl (reviewed in June 2024)

A website about sports betting and online casinos, providing information about the major sports competitions, with a strong focus on the Chilean and international football.

ahtigames.com (reviewed in July 2024)

Finnish-language online casino site offering a variety of games including slots, table games, and live dealer options. The platform provides bonuses, secure payment methods, and an interface tailored for Finnish players.

kryptobull.se (reviewed in June 2024)

A crypto website comparing crypto casinos available for Swedish players.

cazino.ro (reviewed in July 2024)

Online resource offering expert reviews and information on the best casinos in Romania. It features the latest news, updates, and promotions in the gambling industry, helping users make informed choices.

legitgamblingsites.com (reviewed in June 2024)

Expert information for the informed gambler. Blog with both casino and sports topics, strategy guides, and casino reviews in several categories.

References:

Bărboianu, C. (2013). Mathematician's call for interdisciplinary research effort. *International Gambling Studies*, 13(3), 430-433.

Bărboianu, C. (2014). Is the secrecy of the parametric configuration of slot machines rationally justified? The exposure of the mathematical facts of games of chance as an ethical obligation. *Journal of Gambling Issues*, Vol. 29, 1-23.

Bărboianu, C. (2015). Mathematical models of games of chance: Epistemological taxonomy and potential in problem-gambling research. *UNLV Gaming Research & Review Journal*, 19(1), 2.

Bărboianu, C. (2019). The epistemology of the near miss and its potential contribution in the prevention and treatment of problem-gambling. *Journal of Gambling Studies*, 35(3), 1063-1078.

Bărboianu, C. (2022). *Understanding Your Game: A Mathematician's Advice for Rational and Safe Gambling*. PhilScience Press.

Bărboianu, C. (2022). Qualitative analysis of the reflection of the mathematical dimension of gambling in gaming online content – project. *Philscience*. Retrieved from <https://www.philscience.org/pages/gammathqa.html> .

Beresford, K., & Blaszczynski, A. (2020). Return-to-player percentage in gaming machines: Impact of informative materials on player understanding. *Journal of Gambling Studies*, 36(1), 51-67.

Collins, D., Green, S., d'Ardenne, J., & Wardle, H. (2014). Understanding of Return to Player messages. In conference *Harm Minimisation: Investigating Gaming Machines in Licensed Betting Offices*, London (Vol. 10).

Griffiths, M. (1993). Fruit machine gambling: The importance of structural characteristics. *Journal of Gambling Studies*, 9(2), 101-120.

Harrigan, K. A. (2007). Slot machine structural characteristics: Distorted player views of payback percentages. *Journal of Gambling Issues*, Vol. 20, 215-234.

Harrigan, K. A. (2009). Slot machines: Pursuing responsible gaming practices for virtual reels and near misses. *International Journal of Mental Health and Addiction*, 7(1), 68-83.

Lambros, C. & Delfabbro, P. (2007). Numerical reasoning ability and irrational beliefs in problem gambling. *International Gambling Studies*, 7(2), 157-171.

Leonard, C. A., & Williams, R. J. (2016). The relationship between gambling fallacies and problem gambling. *Psychology of Addictive Behaviors*, 30(6), 694.

Probability Theory Guide and Applications. <https://www.probability.infarom.ro>.

Turner, N. E., & Horbay, R. (2004). How do slot machines and other electronic gambling machines really work? *Journal of Gambling Issues*, Vol. 11.