Business Simulation Games Analysis

Subjects: Education & Educational Research
Contributor: Cleiton Ferreira, Diana Adamatti

The search for the best academic training of its students, increasingly aligned with the needs of organizations, has led educational institutions to use support tools in the development and improvement of knowledge, skills, and competencies. Therefore, technology in education is becoming increasingly relevant, and many institutions have been increasing their virtual education strategies due to the COVID-19 pandemic. Thus, the importance of a deeper scientific look at the possible contributions of the Business Simulation Games (BSG) emerges. The few types of research related to the design of BSG, mainly associated with the user experience, point out the need for contributions from other studies. In this sense, the approximation results from investigations with Serious Games can provide relevant insights into the theme. They are active learning tools that present similar didactic principles of demonstrative, activity, accessibility, a combination of theory and practice, scientific character, and involvement, to develop skills and knowledge for its users.

Keywords: business simulation game ; serious game ; EEG ; eye tracking ; learning ; neuroscience

1. Overview

What are the researches related to the learning process with (Serious) Business Games using data collection techniques with Electroencephalogram or Eye tracking signals? The PRISMA declaration method was used to guide the search and inclusion of works related to the elaboration of this study. The 19 references resulting from the critical evaluation initially point to a gap in investigations into using these devices to monitor serious games for learning in organizational environments. An approximation with equivalent sensing studies in serious games for the contribution of skills and competencies indicates that continuous monitoring measures, such as mental state and eye fixation, proved to identify the players' attention levels effectively. Also, these studies showed effectiveness in the flow at different moments of the task, motivating and justifying the replication of these studies as a source of insights for the optimized design of business learning tools. This study is the first systematic review and consolidates the existing literature on user experience analysis of business simulation games supported by human-computer interfaces.

2. Business Simulation Games

The search for the best academic training of its students, increasingly aligned with the needs of organizations, has led educational institutions to use support tools in the development and improvement of knowledge, skills, and competencies [1]. Therefore, technology in education is becoming increasingly relevant, and many institutions have been increasing their virtual education strategies due to the COVID-19 pandemic [2]. Thus, the importance of a deeper scientific look at the possible contributions of the Business Simulation Games (BSG) emerges [3][4].

The few types of research related to the design of BSG, mainly associated with the user experience, point out the need for contributions from other studies. In this sense, the approximation results from investigations with Serious Games can provide relevant insights into the theme. They are active learning tools that present similar didactic principles of demonstrative, activity, accessibility, a combination of theory and practice, scientific character, and involvement, to develop skills and knowledge for its users [5]. With this perspective of analysis, researches with serious games, and applicable to BSG show that to meet the learning demands, it is necessary to contribute beyond the resources of immersion, interactivity, engagement, and similarity to the real world [2][6]. Also, it is needed to include different aspects such as proposed objectives, practical challenges, and ongoing feedback on the learner's performance, which makes evaluation difficult since there is no predetermined object. Still, a space for experimentation with the possibility of successes and errors, in which it is essential to monitor and evaluate the entire process beyond a simple result [7]. In addition to these issues, there are few investigations on the effective contributions of these tools to socioemotional aspects and related to the cognition of their users [8][9].

The development of Serious Games must involve a team integrating people from different areas and knowledge so that each one with their expertise can contribute with elements to a final product that offers its full potential to users [6]. From another perspective, Serious Games can also benefit from information from physiological measurement devices that, in an integrated way, analyze the user experience and can contribute to their design process [10][11][12].

In line with these emerging issues, the proposal of this work is presenting a multidisciplinary study pointing out the current stage in literature areas of Business/Serious Game, Education, and Neuroscience from the following question:

What are the studies related to the learning process with Business (Serious) Games using data collection techniques with electroencephalogram signals or eye tracking?

Although the use of sensors to obtain feedback on human behavior in specific tasks is a widely explored scientific field, especially in the health area, when the purpose is to study their possible contributions to digital business learning tools in teaching spaces, the limitation of investigations is evident. As a marketing strategy for schools and universities, its use is pointed out as a differential in preparing the future professional, but what is effectively known about its benefits is the result of qualitative research. The motivation for this work, while making it unique, arises to bring together the existing findings on ET and EEG devices as a resource for analyzing elements in games and simulators for the development of equivalent studies with BSG. Other technologies can also provide insights, including those mentioned in the studies considered by this SR. Still, the option to focus the scope on these two interfaces, both commercially and scientifically consolidated, is to provide quantitative investigations with BSG in the short term.

The records found in response to this question address the monitoring of physiological characteristics during the user experience of different serious games. It is intended to contribute to the design and improvement of virtual environments for business learning.

3. Background

3.1. Approaching Serious Games and Neuroscience for a Better Learning

The development and search for a continuous improvement of skills and competencies in line with current personal and professional demands, which go beyond technical knowledge, has been recommended by organizations recognized worldwide. And their research points to the need to constantly improve high-level thinking, creativity, collaboration, and the ability to analyze problems and make decisions, among other elements, as the secret to success in life [9][13][14].

One of the biggest challenges of teaching has been establishing the balance between theory and practice. Commonly, the knowledge developed in the academic environment presents a minimal view of organizations and their processes, as a static model, without the possibility of changes [15]. Despite some research showing that only a tiny part of the knowledge acquired by the students can be applied in professional life [16][17], this scenario has been changing. A recent survey of higher education students shows the recognition of digital media as a way of empowerment that allows them to get the most out of educational opportunities because they are more flexible and adaptive. Also, this study highlights that it is a way to develop digital skills and transversal skills in all contexts of life, whether personal, social, or professional. In this sense, it is already a reality that institutions worldwide, aware of the potential of this digital environment, are adopting Serious Games, including business ones, as a learning strategy [18][19]. In these virtual tools, the learner can experience dynamic situations in the most diverse environments, approaching different realities of the organization, building new possibilities of organizational processes. The student interacts as a key figure so that the exercise of planning, organization, and decision-making is as or more important than the final result [20]. Added to the impact of serious games, the development of skills such as analytical thinking, transfer and retention of knowledge, motivation, adaptive learning, change in the way of seeing and facing situations [21][22][23], it can contribute to obtaining and redeeming content, offering subsidies for a possible reconstruction of a moment or context.

From a neuroscientific point of view, when dealing with something unusual and different, the brain tries to connect to an existing neural network providing new information. This information potentially increasing the retention of information, considering that a new situation makes sense or has real meaning when it fits into a pre-existing neuronal pattern. [8][24][25].

Another relevant element of behavior is a close correlation between emotion and brain functions. Specifically, the limbic and paralimbic systems, the vegetative nervous system, and reticular activation are closely related to the processing and control of emotional behavior [26]. As for affectivity, the serious game contributes to the development of technical and intellectual knowledge, obtained through a constant integration of the functional areas of the brain, improving learning.

Concerning group learning, the contribution through serious games is given by the dynamics that explore teamwork, which brings a more independent learning character and helps develop social and interpersonal skills. [21][27][28].

Studies in the field of neuroscience have offered insights into simulation and Serious Games. They have collaborated with elements to create advanced learning models that increase brain volume, develop neuronal plasticity from its use, and improve visual acuity, increasing motor coordination and memory beyond simple recognition. [29][30][31].

3.2. Definition and Elements of Business Simulation Games (BSG)

Simulators and Serious Games are digital environments designed with the objective of teaching or training through an experience that goes beyond entertainment and fun (without necessarily excluding such characteristics), using technological resources, and following gamification methods in an approach to daily situations. According to [32], "*A simulation is a working representation of reality; it may be an abstracted, simplified or accelerated model of a process. It purports to have a relevant behavioral similarity to the original system*". The same author highlights that simulation and serious games "*combines the features of a game (competition, cooperation, rules, participants, roles) with those of a simulation*," and further concludes that "A serious game is a simulation game if its rules refer to an empirical model of reality".

The BSG constitutes a real example of an e-learning methodology in business education [33][34][35], due to it manages to bring, to the virtual format, real aspects of a business environment, enabling apprentices to manage companies in risk-free scenarios and offering a broad view of the strategic functions that permeate corporations, in an attractive and interactive approach [36]. Any game that presents an organizational setting and incorporates whatever the characteristics of the "business world" should be considered a BSG and should be categorized as a "simulation game" or "serious game," unless it offers an educational approach wrong or that manifest deliberately unrealistic reactions to the choices of its users [37]. A BSG can be used as a learning tool, simulating market trends or corporate behaviors to provide a strategic view [38][39][40], be it a new business or already established.

The first and more recognized classification developed for the BSG [38] considered that this instrument under the design aspect could present itself as: total enterprise or functional interacting or noninteracting, and computer or noncomputer; and according to their expected use: as a part of a general management training program; for selling new techniques or procedures, or for conducting research. As a method that presents itself to conduct more effective learning, simulation games should provide and improve skills and instigate the evaluation of results and feedback for those who use them [41]. It means adding features related to the fidelity, verification, and validation of the proposed model and the tool itself, such as interactivity and immersion capacity [42], such as the potential to establish the sequence in decisions, in addition to an interface and friendly appearance [37].

Regarding the systematization of research on the modeling of a game, the Taxonomy of Computer Simulations [43] and then adapted for the BSG [37] considers the following macro-categories: Environment of application; Design elements of the user interface; Target groups, Goals & Feedback; User relation characteristics; Characteristics of the simulation model.

Interactive systems design must contemplate several aspects, such as attention, essential human capacity in executing tasks. The author highlights the importance of working on resources that recognize recourse and devices such as assistants and automatic error checkers for possible deviations in attention in interactive systems design. These resources are significant to simulate the reasoning of an expert professional in a specific area of knowledge, capable of offering suggestions and advice to its users [42]. The author also highlights the relevant aspect of social interaction in this context, as individuals' thoughts, feelings, and behaviors are influenced by the presence of others. They do not exist; they decide that a simulation system's social effect is significant for its users.

It is essential to consider the possibility of investigating new methodologies and devices to monitor and analyze the user experience of BSG, considering the high level of complexity and multiplicity of operational and project requirements presented it can contribute with essential elements to guide its design and success as a learning tool.

3.3. Human-Computer Interfaces Supporting the BSGs User Experience

Physiological and neuroscientific techniques support the development of human-computer interfaces with investigations from psychophysics, cognitive neuroscience, and computer science. Together have strived to understand the interaction of people with technologies, including learning through games. A recent scientific publication presented the most prominent methods in this area [44], highlighting electroencephalography (EEG) and eye tracking (ET). It considered the two support techniques most used and more effective in the business context [45][46][47][48]. It presented its forms of operation, functionalities, limitations, and possible contributions in the context of the BSG.

3.3.1. Electroencephalography (EEG)

Electroencephalography, based on the capture of brain signals, has been one of the most used non-invasive methods to capture and analyze human behavior. To record these signals, the person studied wears a cap with electrodes attached to it, establishing contact with the brain. The equipment captures minor variations in its activity from stimuli during a predefined activity. At each moment when the neuron is activated, a polarization occurs, and a consequent action potential is transmitted to other neurons, thus creating a current of information that generates an electrical activity captured by the electrodes and, subsequently, is sent to the module. Electronic for a process of filtering and subsequent data mining [49]. The signals captured through the electrodes reflect the intensity of the brain waves generated in the scalp. The most advanced EEG devices have a high temporal resolution, capturing activity in milliseconds, and excellent precision in spatial resolution. The equipment is currently being made available in portable sizes and has relatively affordable prices in some versions, allowing a greater diffusion in its use [50].

The application of EEG for the recognition of emotion and mental effort has already been the objective of a reasonable number of studies [51][52][53][54], using different methodologies for collecting, classifying, and analyzing signals for applications such as medicine and education. Although the temporal resolution of most EEG devices is considered high, as already mentioned, the spatial resolution is deemed to be limited. However, it is still possible to identify the general origin of the EEG, providing important information about the types of mental processes occurring in a given moment or situation, which can already be considered relevant to understanding human behavior. [44]. In necessary research [55], several models for data extraction with EEG in human activities methods were analyzed and proposed from collected data. In other investigations, measurements of EEG signals were applied in the analysis of the response of game users [56][57], and expert researchers discussed methodological advances in player experience and playability, highlighting EEG-based results as a good measure for analyzing cognitive behavior [58].

The experience with the BSG provides various mental and emotional states in the definition of strategies and decision-making when playing. Thus, the EEG proves to be a very recommendable monitoring sensor. It allows the identification of the activation of different brain regions, such as the frontal lobe and memory-related areas, happening in situations requiring figurative and analytical reasoning, and occipital and parietal lobe areas, during movement perception and demand for visuospatial attention [56][57][58].

3.3.2. Eye Tracking (ET)

Eye tracking is a method that registers visual attention directly and continuously. This method has been applied generally to monitor the user's attention, using a device that emits infrared rays directly into their eyes, making it possible to determine with considerable precision where you are looking. Also, it allows measuring eye movements and data related to fixations, visions, and regressions [59]. ET devices have been applied in the diagnostic area through eye movement records and corresponding visual behavior, providing results very quickly [60][61]. The following metrics can be collected through ET during system evaluation of a predefined activity, including performance measures: Efficiency and Effectiveness; for process measures: Number of fixations and Fixations, Attentional switching, and scan path similarity [62][63].

The use of ET to monitor visual behavior in a given situation provides patterns that reflect the most varied interactions between the stimulus received, the region of eye activation, the neuron temporal response characteristics, and the positions of the retina along with the image movements.

The wide variation in activity patterns suggests that, during the visualization of a stationary scene, some cortical neurons transmit information about the occurrences and directions of the balconies. In contrast, others assume the role of encoding details of the retinal image, playing a double benefit: monitoring brain activity and acting on oculomotor function [62]. Considering the reported functionalities, currently, the ET devices have been used in fields such as marketing [47][48][64], analysis of the usability of games and virtual environments [65][66][67], and recently in human behavior and applied neuroscience research [62][68]. Also, it includes the use of EEG- and ET-based measurement interfaces in an integrated manner, comparing and complementing results [65].

The structure of a BSG usually must establish a series of managerial information that require the player's attention, and at the same time, provide enough elements for their success in the experience with the tool. The sensing of these behaviors through ET allows us to understand how the player takes advantage, or not, of the potential offered by the game from the control of the saccades and eye fixations. Other features such as heat maps identify levels of more or less involvement in certain screens in analyzing what sustains attention and motivation.

4. Conclusions

In the search for possible connections between the selected studies, what draws a lot of attention is the recurrent use of the term performance. By analyzing this common point, it is clear that it is a guide for investigations that establish relations between the measurements provided by sensors (TE or EEG) during the player’s achievement and his actual result in the game. At the same time that they prove the applicability of measuring devices in monitoring the experience of users with the SG, these researches point to contributions to the design of this learning tool. In each study, the adopted methodology seeks to prove, with the results obtained, aspects such as level of attention, mental effort, degree of stress, level of learning, perception of difficulty, flow, concentration, satisfaction, motivation, problem solving strategy and fatigue. In any aspect(s) addressed by the investigations, it is highlighted that the detection of signals occurs relatively simply and in real time, which significantly reduces the possibility of errors or inconsistent results. Data generation during the full game, made possible by these models of non-invasive data collection devices, is also a feature of all experimental investigations selected in this SR that should be adopted in experiments with BSG. Monitoring how the player behaves over time at different difficulty levels, phases, screens and state changes offered by the game provides comparable data that lead to very consistent conclusions. These results allow to effectively establish which game elements influence the acquisition and retention of knowledge and skills.

References

1. Haigler, K. The Role of Occupational Research in Complex Assessments: Aligning Educational Practices with Workplace Requirements. J. Writ. Anal. 2021, 5, 259–291.
2. Zea, E.; Valez-Balderas, M.; Uribe-Quevedo, A. Serious Games and Multiple Intelligences for Customized Learning: A Discussion; Springer International Publishing: Cham, Switzerland, 2021; Volume 196.
3. Zulfiqar, S.; Al-Reshidi, H.; Al Moteri, M.; Feroz, H.; Yahya, N.; Al-Rahmi, W. Understanding and Predicting Students’ Entrepreneurial Intention through Business Simulation Games: A Perspective of COVID-19. Sustainability 2021, 13, 1838.
4. Bondar, I.; Gumenyuk, T.; Horban, Y.; Karakoz, O.; Chaikovska, O. Distance E-Learning in the System of Professional Development of Corporation Managers: Challenges of COVID-19. J. Educ. E Learn. Res. 2020, 7, 456–463.
5. McGlarty, K.L.; Orr, A.; Frey, P.M.; Dolan, R.; Vassileva, V.; McvAy, A. A Literature Review of Gaming in Gaming. Gaming Educ. 2012, 1–36. Available online: (accessed on 10 May 2021).
6. Dimitriadou, A.; Djafarova, N.; Turetken, O.; Verkuyl, M.; Ferworn, A. Challenges in Serious Game Design and Development: Educators’ Experiences. Simul. Gaming 2021, 52, 132–152.
7. Ratwani, K.L.; Orvis, K.L.; Knerr, B.W. Game-Based Training Effectiveness Evaluation in an Operational Setting; Aptima Inc.: Woburn, MA, USA, 2010; Volume 1, p. 34. Available online: (accessed on 12 May 2021).
8. Lent, R. Cem Bilhões de Neurônios: Conceitos Fundamentais de Neurociência; Atheneu: São Paulo, Brazil, 2001.
9. Santos, D.; Primi, R. Desenvolvimento Socioemocional e Aprendizado Escolar: Uma Proposta de Mensuração para Apoiar Políticas Públicas; Instituto Ayrton Senna: São Paulo, Brazil, 2014; p. 87.
10. Hookham, G.; Nesbitt, K. A Systematic Review of the Definition and Measurement of Engagement in Serious Games. In Proceedings of the ACSW 2019: Australasian Computer Science Week Multiconference, Sydney, Australia, 29–31 January 2019; 2019.
11. Zarraonandia, T.; Paloma, D.; Santos, A.; Montero, Á.; Aedo, I. Games and Learning Alliance. In Proceedings of the International Conference on Games and Learning Alliance, Palermo, Italy, 5–7 December 2018; Volume 10653, pp. 297–307.
12. Petko, D.; Schmid, R.; Cantieni, A. Pacing in Serious Games: Exploring the Effects of Presentation Speed on Cognitive Load, Engagement and Learning Gains. Simul. Gaming 2020, 51, 258–279.
13. Bontinck, G.; Isik, Ö.; Van Den Bergh, J.; Viaene, S. Unlocking the Potential of the Process Perspective in Business Transformation. In Proceedings of the Business Process Management Forum Brazil, Rio de Janeiro, Brazil, 18–22 September 2016; Volume 64, pp. 161–176.
14. Prifti, L.; Knigge, M.; Löffler, A.; Hecht, S.; Krcmar, H. Emerging Business Models in Education Provisioning: A Case Study on Providing Learning Support as Education-as-a-Service. Int. J. Eng. Pedagog. (IJEP) 2017, 7, 92.

15. Monk, E.F.; Lycett, M. Measuring business process learning with enterprise resource planning systems to improve the value of education. Educ. Inf. Technol. 2016, 21, 747–768.
16. Baldwin, T.T.; Pierce, J.R.; Joines, R.C.; Farouk, S. The Elusiveness of Applied Management Knowledge: A Critical Challenge for Management Educators. Acad. Manag. Learn. Educ. 2011, 10, 583–605.
17. Neves, C.; Henriques, S. Exploring the Impacts of Distance Higher Education on Adult Learners' Lives and Reclaiming Lifelong Learning as a Human Development Process. Open Prax. 2020, 12, 439.
18. Andersen, R.; Bonnier, K.E.; Jaccard, D. Challenges with the Introduction of a «Project Management Game» in Higher Education. In Proceedings of the Edulearn20: 12th International Conference on Education and New Learning Technologies, Virtual Conference, University of Agder, Kristiansand, Norway, 6–7 July 2020.
19. Ma, Y.; Vallet, F.; Cluzel, F.; Yannou, B. Analysing the Relevance of Serious Game Elements for Effectively Teaching Innovation. In Proceedings of the Design Society: International Conference on Engineering Design, ICED, Delft, The Netherlands, 5–8 August 2019; pp. 439–448.
20. Barçante, L.C.; Pinto, F.C. Jogos de Negócios: Revolucionando o Aprendizado nas Empresas; Impetus: Rio de Janeiro, Brazil, 2003.
21. Abdullah, N.L.; Hanafiah, M.H.; Hashim, N.A. Developing Creative Teaching Module: Business Simulation in Teaching Strategic Management. Int. Educ. Stud. 2013, 6, 95–107.
22. Zhonggen, Y. A Meta-Analysis of Use of Serious Games in Education over a Decade. Int. J. Comput. Games Technol. 2019, 2019, 1–8.
23. Mettler, T.; Pinto, R. Serious Games as a Means for Scientific Knowledge Transfer—A Case From Engineering Management Education. IEEE Trans. Eng. Manag. 2015, 62, 256–265.
24. Gazzaniga, M.; Heatherton, T.; Halpern, D. Ciência Psicológica; Artmed Editora. 2005. Available online: (accessed on 7 June 2021).
25. Izquierdo, I. Memória; ArtMed: Porto Alegre, Brazil, 2002.
26. Bălan, O.; Moise, G.; Petrescu, L.; Moldoveanu, A.; Leordeanu, M.; Moldoveanu, F. Emotion Classification Based on Biophysical Signals and Machine Learning Techniques. Symmetry 2019, 12, 21.
27. De Freitas, S.; Jarvis, S. A Framework for Developing Serious Games to Meet Learner Needs. In Proceedings of the Interservice/Industry Training, Simulation&Education Conference (I/ITSEC), Orlando, FL, USA, 4–7 December 2006; No. 2742. pp. 1–11. Available online: (accessed on 17 May 2021).
28. Buzady, Z.; Almeida, F. FLIGBY—A Serious Game Tool to Enhance Motivation and Competencies in Entrepreneurship. Informatics 2019, 6, 27.
29. Green, C.S.; Bavelier, D. Exercising Your Brain: A Review of Human Brain Plasticity and Training-Induced Learning. Psychol. Aging 2008, 23, 692–701.
30. Kühn, S.; The IMAGEN Consortium; Romanowski, A.; Schilling, C.; Lorenz, R.; Mörsen, C.; Romanczuk-Seiferth, N.; Banaschewski, T.; Barbot, A.; Barker, G.; et al. The Neural Basis of Video Gaming. Transl. Psychiatry 2011, 1, e53.
31. Kuhn, S.; Gleich, T.; Lorenz, R.C.; Lindenberger, U.; Gallinat, J. Playing Super Mario Induces Structural Brain Plasticity: Gray Matter Changes Resulting from Training with a Commercial Video Game. Mol. Psychiatry 2014, 19, 265–271.
32. Ruohomaki, V. Viewpoints on Learning and Education with Simulation Games. In Simulation Games and Learning in Production Management; Riis, J.O., Ed.; Chapman&Hall: London, UK, 1995; pp. 14–28.
33. Siddiqui, A.; Khan, M.; Akhtar, S. Supply Chain Simulator: A Scenario-Based Educational Tool to Enhance Student Learning. Comput. Educ. 2008, 51, 252–261.
34. Hernández-Lara, A.B.; Serradell-Lopez, E. Fitó-Bertran, Àngels Do Business Games Foster Skills? A Cross-Cultural Study from Learners' Views. Intang. Cap. 2018, 14, 315–331.
35. Lin, H.-H.; Yen, W.-C.; Wang, Y.-S. Investigating the Effect of Learning Method and Motivation on Learning Performance in a Business Simulation System Context: An Experimental Study. Comput. Educ. 2018, 127, 30–40.
36. Pando-Garcia, J.; Periáñez-Cañadillas, I.; Charterina, J. Business Simulation Games with and without Supervision: An Analysis Based on the TAM Model. J. Bus. Res. 2016, 69, 1731–1736.
37. Greco, M.; Baldissin, N.; Nonino, F. An Exploratory Taxonomy of Business Games. Simul. Gaming 2013, 44, 645–682.
38. Eilon, S. Management Games. J. Oper. Res. Soc. 1963, 14, 137–149.
39. Diachkova, A.V.; Sandler, D.G.; Avramenko, E.S. Case of Using Simulation in Education for Business Analysts. Econ. Consult. 2020, 31, 104–114.

40. Toma, R.C.; Mărgărit, G.; Garais, G.; Matei, F. E-Learning Platform for Start-Up Simulation in Life Science and Business Field-a Useful Educational Tool. Sci. Pap. Manag. Econ. Eng. Agric. Rural Dev. 2020, 20, 493–498. Available online: (accessed on 18 May 2021).

41. ABNT. NBR ISO 10015: Gestão da Qualidade-Diretrizes para Treinamento; Associação Brasileira de Normas Técnicas: Rio de Janeiro, Brazil, 2020; p. 12.

42. Benyon, D. Designing Interactive Systems: A Comprehensive Guide to HCI, UX, and Interaction Design. 2013. Available online: (accessed on 7 June 2021).

43. Maier, F.H.; Größler, A. What are we Talking About?-A Taxonomy of Computer Simulations to Support Learning. Syst. Dyn. Rev. 2000, 16, 135–148.

44. Bell, L.; Vogt, J.; Willemse, C.; Routledge, T.; Butler, L.T.; Sakaki, M. Beyond Self-Report: A Review of Physiological and Neuroscientific Methods to Investigate Consumer Behavior. Front. Psychol. 2018, 9, 1655.

45. Aricò, P.; Borghini, G.; Di Flumeri, G.; Sciaraffa, N.; Babiloni, F. Passive BCI beyond the Lab: Current Trends and Future Directions. Physiol. Meas. 2018, 39, 08TR02.

46. Teo, J.; Chia, J.T. EEG-Based Excitement Detection in Immersive Environments: An Improved Deep Learning Approach. AIP Conf. Proc. 2018, 2016, 020145. Available online: (accessed on 7 June 2021).

47. Burger, C.A.C.; Knoll, G.F. Eye Tracking: Possibilidades de uso da Ferramenta de Rastreamento Ocular na Publicidade. Front. Estud. Midiáticos 2018, 20, 340–353.

48. Oliveira, J.H.C.; Giraldi, J.D.M.E. Neuromarketing and Its Implications for Operations Management: An Experiment with Two Brands of Beer. Gest. E Prod. 2019, 26.

49. Eysenck, M.W.; Keane, M.T. Manual de Psicologia Cognitiva; Artmed: Porto Alegre, Brazil, 2010.

50. Kugler, M. Uma Contribuição ao Desenvolvimento de Interfaces Cérebro-Computador Utilizando Potenciais Visualmente Evocados; Universidade Tecnológica Federal do Paraná: Curitiba, Brasil, 2003.

51. Gupta, V.; Chopda, M.D.; Pachori, R.B. Cross-Subject Emotion Recognition Using Flexible Analytic Wavelet Transform from EEG Signals. IEEE Sens. J. 2019, 19, 2266–2274.

52. Chao, H.; Zhi, H.; Dong, L.; Liu, Y. Recognition of Emotions Using Multichannel EEG Data and DBN-GC-Based Ensemble Deep Learning Framework. Comput. Intell. Neurosci. 2018, 2018, 1–11.

53. García-Martínez, B.; Martínez-Rodrigo, A.; Alcaraz, R.; Fernández-Caballero, A.; González, P. Nonlinear Methodologies Applied to Automatic Recognition of Emotions: An EEG Review. Trans. Petri Nets Other Models Concurr. XV 2017, 10586, 754–765.

54. Zhang, J.; Xu, H.; Zhu, L.; Kong, W.; Ma, Z. Gender Recognition in Emotion Perception Using EEG Features. In Proceedings of the 2019 IEEE International Conference on Bioinformatics and Biomedicine (BIBM), San Diego, CA, USA, 18–21 November 2019; Institute of Electrical and Electronics Engineers (IEEE): Piscataway, NJ, USA, 2019; pp. 2883–2887.

55. Wolpaw, J.; Birbaumer, N.; Heetderks, W.J.; McFarland, D.J.; Peckham, P.H.; Schalk, G.; Donchin, E.; Quatrano, L.A.; Robinson, C.J.; Vaughan, T.M. Brain-Computer Interface Technology: A Review of the First International Meeting. IEEE Trans. Rehabil. Eng. 2000, 8, 164–173.

56. Salminen, M.; Ravaja, N. Oscillatory Brain Responses Evoked by Video Game Events: The Case of Super Monkey Ball 2. Cyberpsychol. Behav. Impact Internet Multimed. Virtual Real. Behav. Soc. 2007, 10, 330–338.

57. Sheikholeslami, C.; Yuan, H.; He, E.; Bai, X.; Yang, L.; He, B. A High Resolution EEG Study of Dynamic Brain Activity during Video Game Play. In Proceedings of the 2006 International Conference of the IEEE Engineering in Medicine and Biology Society, Lyon, France, 22–26 August 2007; pp. 2489–2491.

58. Nacke, L.E. Affective Ludology: Scientific Measurement of User Experience in Interactive Entertainment. 2009. Available online: (accessed on 7 June 2021).

59. Lu, Q.; Zhang, J.; Chen, J.; Li, J. Predicting Readers' Domain Knowledge Based on Eye-Tracking Measures. Electron. Libr. 2018, 36, 1027–1042.

60. Zhu, J.; Wang, Z.; Gong, T.; Zeng, S.; Li, X.; Hu, B.; Li, J.; Sun, S.; Zhang, L. An Improved Classification Model for Depression Detection Using EEG and Eye Tracking Data. IEEE Trans. NanoBiosci. 2020, 19, 527–537.

61. Mele, M.L.; Federici, S. Gaze and Eye-Tracking Solutions for Psychological Research. Cogn. Process. 2012, 13, 261–265.

62. Duchowski, A.T. Eye Tracking Methodology: Theory and Practice, 2nd ed.; Springer: London, UK, 2007.

63. Karras, O.; Risch, A.; Schneider, K. Interrelating Use Cases and Associated Requirements by Links: An Eye Tracking Study on the Impact of Different Linking Variants on the Reading Behavior. In Proceedings of the EASE'18: 22nd International Conference on Evaluation and Assessment in Software Engineering, Christchurch, New Zealand, 28–29 June 2018; pp. 2–12.
64. Utriainen, T. Neuromarketing and Consumer Neuroscience-The Evolution and Current State of the Art, an Integrative Review. 2019, p. 64. Available online: (accessed on 7 June 2021).
65. Cuesta-cambra, U.; Rodríguez-terceño, J. El Procesamiento Cognitivo en una app Educativa con Electroencefalograma y «Eye Tracking». Comunicar 2017, XXV, 41–50.
66. Soler-Dominguez, J.L.; Camba, J.D.; Contero, M.; Alcañiz, M. A Proposal for the Selection of Eye-Tracking Metrics for the Implementation of Adaptive Gameplay in Virtual Reality Based Games. Trans. Petri Nets Other Models Concurr. XV 2017, 10280, 369–380.
67. Da Silva, A.C.; Sierra-Franco, C.A.; Silva-Calpa, G.F.M.; Carvalho, F.; Raposo, A.B. Eye-tracking Data Analysis for Visual Exploration Assessment and Decision Making Interpretation in Virtual Reality Environments. In Proceedings of the 2020 22nd Symposium on Virtual and Augmented Reality (SVR), Porto de Galinhas, Brazil, 7–10 November 2020; pp. 39–46.
68. Carvalho, M.; Oliveira, L. Emotional Design in Web Interfaces. Observatorio 2017, 11, 14–34.