

Serious Game Design for Children

A set of guidelines and their validation

Authors Name/s per 1st Affiliation (*Author*)

line 1 (of *Affiliation*): dept. name of organization
line 2: name of organization, acronyms acceptable
line 3: City, Country
line 4: e-mail: name@xyz.com

Authors Name/s per 2nd Affiliation (*Author*)

line 1 (of *Affiliation*): dept. name of organization
line 2: name of organization, acronyms acceptable
line 3: City, Country
line 4: e-mail: name@xyz.com

Abstract— *Digital games can be used as allies to support and motivate the learning process. Many academic works focus their studies in the so-called Serious Games (SG), which are games whose primary objective is not solely entertainment. What happens, however, is that these games end up being far from children's expectations, especially when compared to commercial games. Thus, this work proposes a set of guidelines that can be followed by designers and developers of SG for children, guiding the design decisions so that the final product would be better suitable to children. The set of guidelines was obtained through SG analysis of child-oriented and child technology recommendations, leading to a total of forty guidelines that are divided into four groups: input, output/interface, content, and control. They have been assessed by 59 experts which concluded that they were all worth attention when designing SG for children.*

Keywords- *Serious Game; Game Design; Children; Guidelines.*

I. INTRODUCTION

Some of the benefits brought by the use of games on education, besides the improvement of learning, are the motivating effect [1] and the development of cognitive abilities to solve problems, creativity and critical thinking [2]. These advantages can even benefit students with concentration problems [3].

In addition, skills such as learning by discovery [4], motor and spatial coordination [5] and expert behavior [6] are also developed while the player has fun. Games are "the best way to lead the child to activity, self-expression, knowledge and socialization" [7]. These benefits become even more accessible when the target audience is composed by children, since they are already familiar with technology and are Digital Natives [8].

However, there is an obstacle to all education Serious Games (SG): they are still little used because achieving a balance between quality and fun has been shown to be a difficult task [9]. Also, there are few studies that deal with the adequacy of SG design for children and those who did, reported only a few useful characteristics of the design, as will be shown by the related works.

The objective of this paper is to present a set of guidelines to help design SG for children and the validation process used to assess their relevance by experts.

II. THEORETICAL FOUNDATION

A Serious Game (SG) is a game designed for a primary purpose other than pure entertainment [35]. In a formal definition it is "a mental contest, played with a computer according to specific rules, which uses entertainment for the purpose of government or business training, education health, public policy, and strategic communication objectives" [36].

Child-Computer Interaction (CCI) is an area of scientific investigation that is concerned with the phenomena surrounding the interaction between children and computational and communication technologies [10, p. 1]. CCI encompass the study of the design, evaluation, and implementation of interactive computer systems for children, and the wider impact of technology on children and society [12]. CCI addresses the study of children's activities, behaviors, concerns, and abilities, as they interact with computer technology [11].

Guidelines, are high-level statements ranging from a wide variety of cases to low-level declarations limited to specific contexts [14]. Guidelines are recommendations to designers and developers when there are no specific standards. Guidelines are designed to certain processes according to what the best practices are. These are then practical questions that are intended to guide the decisions of the product development process.

Guidelines serve as a way to achieve design principles, which are, in practical terms, tips on how a system should be at its final stage, reminders of aspects to be contemplated or how it should be developed [15]. Guidelines also relate to design heuristics, with the difference that heuristics are essentially observed in practice [16].

The compilation of guidelines assists less experienced designers by showing a path to be followed, preventing them from pitfalls during the design [17]. Furthermore, the use of guidelines helps designers to reflect on their practices, evaluating whether they should be applied and/or refined to the work context. The goal of the guidelines is assisting researchers and designers who find themselves in similar contexts and problems [15].

III. RELATED WORK

The work of [18] explored the experiences gained in three learning environment projects that involved the collaboration of elementary school children. The work discusses the expectations that this target audience has in relation to the interface of a software and its content. These expectations were categorized into four sets: (i) interface; (ii) appearance; (iii) theme, and; (iv) content.

Chorianopoulos et al. [19] present three design principles for SG in Mathematics, which are: (i) involving the player with a hero story; (ii) employing familiar games mechanics and; (iii) provide a constructive trial-and-error feedback to promote learning. In order to illustrate the application of these three principles, the authors developed a SG for teaching addition and subtraction with a focus on children of 13 and 14 years of age.

From an extensive research on technologies for children, [13] presents a catalog of design principles for technologies aimed at this public considering their needs, abilities and expectations. The goal of this catalog is helping the designers in finding these design recommendations in an organized way and in one place. The catalog is organized into three categories: (i) cognitive, composed of literacy, feedback, mental development and imagination; (ii) physical, which refer to motor skills and tangibility, and; (iii) social/emotional, which relate to engagement, social interactions and collaboration.

According to Chiasson and Gutwin [13], recommendation sets organized in an objective way to aid in the design of systems to children are scarce, often making designers adopt the same principles for traditional interfaces that are focused on adults.

The work developed by [20] aimed at presenting formative and objective analysis of relevant pedagogical aspects in the process of children interaction with a game involving logic programming. According to the authors, these parameters present the potential to compose a method of evaluating games of this target group. The authors' perception, however, was that educational systems have their own characteristics, so that general heuristics do not always apply. In this way, based on the assumption that heuristics are considered an effective method of evaluating interfaces, the formative evaluation was analyzed in order to exceed Nielsen heuristics [16] to the context of educational software. The heuristics were approached from three groups: exploratory interaction; visual metaphors of the interface, and; interaction design.

These related works described only partial and limited initiatives to assist SG design for children and clearly show the need for a bigger and unified set of guidelines because some findings are complementary and others overlap. The set of guidelines we composed contains 40 guidelines and were divided into four categories, as will be explained next.

IV. METHODOLOGY AND GUIDELINES PROPOSAL

The process to achieve the set of guidelines was based on the aspects observed in the design, development and evaluation of SG for children and their contribution to the CCI area. We conducted a literature search where "Serious Games for Children" and "Game Guidelines for Children"

were the main keywords. From the 15 papers initially found, we analyzed in each paper their set of guidelines, their related works and, their references. Subsequently, authors and works commonly observed were also investigated, resulting in a final set of 29 sources, as it appears in Table I which also presents objectively our set of guidelines.

The guidelines were grouped as follows: Input Guidelines (G_1 to G_6); Output/Interface Guidelines (G_7 to G_{25}); Content Guidelines (G_{26} to G_{37}); Control Guidelines (G_{38} to G_{40}). The grouping of the guidelines allows the designer to identify which elements, according to the set of guidelines, should be better analyzed to suit children's audience. Each guideline is followed by the references from which it was obtained directly or by interpretation. When the age range or infancy stage is not informed, it is understood that the source from which the guideline was taken did not explicitly make this information available, and in this way, it is considered that the recommendation is not restricted to a specific period of childhood.

For a description of the guidelines, readers should see [47] and, for a more detailed explanation of them, see [48].

V. VALIDATION

In order to validate the guidelines, we sent an electronic questionnaire in Portuguese to 868 experts by email from which 59 subjects answered. Experts' emails were gathered from authors that published full or short papers related to children in the SBGames (Brazilian Symposium on Games and Digital Entertainment) from 2016 to 2018 and in SBIE (Brazilian Symposium on Informatics in Education) in 2018.

We asked experts if they considered each guideline to be appropriate; clear, and; important regarding designing games for children. First question yielded an index from 0 to 10 considering the number of positive responses divided by the total number of answers. Last two questions were answered by choosing a value between 0-none to 10-a lot. Each guideline was presented as a "key phrase" (as listed in Table I) and a descriptive paragraph underneath. At the end of each group of guidelines, we asked open questions if subjects found them to be conflicting between each other; repeated, or; overlapping and, at the very end of the questionnaire we asked for "doubts, complaints and/or suggestions".

Experts that answered were 54,2% male and 45,8% female, and they had 30,5% PhD; 39,0% master and; 20,3% graduate degrees. They were of 34,7 years of age on average ($sd = \pm 10,38$) and with 10,78 years of experience on game/children relate issues on average ($sd = \pm 8,26$). Most of them work on software-related (37,3%), education-related (35,6%) and game-design (15,2%) research/development.

To obtain an overall understanding of each guideline a "Relevance score" was calculate as the average between clearness, agreement and importance scores. All these values are shown in Table I with their mean (μ) and standard deviation (sd) values.

Only two guidelines (G_{19} and G_{21}) scored Relevance below 7,0: Guideline G_{19} might have scored low because it is an heuristic from HCI and, somehow might conflict with the attempt to reduce attention and concentration loads, expressed by G_{37} . Guideline G_{21} , besides being not trivial regarding SG design for children might be conflicting to the common sense that interfaces for children should be colorful

and iconic. “Relevance” gives a better evaluation of each guideline usefulness because it is not enough to have one that is clear but unimportant or, agreed but unclearly stated.

Regarding open questions 14 subjects answered on the “doubts, complaints and/or suggestions” field; 23 answered “conflicting guidelines”; 1 answered “repeated guidelines”, and; 4 answered “overlapping guidelines”.

Most of the subjects used the space to congratulate on the work or to ask details on specific Guidelines (that can be found in their source reference). Actual suggestions include: ranking the guidelines by relevance; develop a checklist; better specify children’s age; to shrink the list by focusing only on what is related exclusively to SGs; to better specify if Guidelines apply to children with special needs, and; the length and time spent on the questionnaire.

To answer these comments, we stress that we only reported what was found and, sometimes, the source did not specify some details but we could see it was surely dealing with children and SGs. We agree that some Guidelines might be applied to specific age span or specific group (autistic children) but we reckon that all of them should be considered while designing a SG regardless because, the broader the analysis, the better the design.

VI. DISCUSSION

Although it is not a new topic and it is an important issue, it was quite difficult to find research papers in the literature with guidelines proposal for designing games for children. That’s why we looked up papers that were presenting SG for children as a starting point. Their approach was studied and compared to others to see how children’s needs were complied to. We found some conflicts regarding to the amount of content that should be presented to children in the computer/game screen: some suggested it should be dense and others, to be as simple as possible. When conflicting guidelines appeared, it was looked at the number of papers that backed it up: those guidelines with more related papers were included in our list.

Children’s population can be sub-divided into many sub-groups such as children that can (already) read, children with special needs (autism, Down syndrome, etc.) and, children of different ages. We see that these differences would yield different guidelines (some would be rendered inappropriate and some new ones could arise). However, authors did not detail such issues and then, we included all of them, regardless.

It is possible to observe from Table 1 that reference [13] contributed with 10 guidelines; [27] with 9; [18] with 8; [23] with 7; [29] with 5; and all the remaining references contributed with less than 5 guidelines. Ten references contributed with 2 guidelines and eight references contributed with only one guideline.

Most of the guidelines (26) scored Relevance above 9,0 and 22 scored above 8,0. Even the lowest scores were above the middle of the scale which suggest that experts found the set of guidelines to be worth a lot of attention while designing a SG for children.

VII. CONCLUSION

Considering that exposing children to technology and to games in particular is becoming ever so usual, it is important

that these artifacts must be designed accordingly to its target audience taking into account users’ skills, interests and needs [12]. These careful design and development are essential to produce serious games of higher standards of quality. Investigating which design decision produce a better solution is valuable to compose a set of design guidelines specially targeted to this population. However, doing so seems to be rare and we could find just a few organized and tested guidelines (most of them lessons learnt from projects of a different goal). It is usual therefore, that designers were taken general principles for traditional interfaces which are aimed for adults [13] but this is far from a good approach for children.

This paper presented a set of guidelines gathered from the scientific literature of projects specially targeting children and game design. Guidelines presented here, although gathered from the literature still need further research to better specify scope of application for children (regarding age, sex, game genre, and special needs, for instance). Also, the set was not meant to be complete neither final. As long as technology and children’s interaction with them changes the guidelines will also change. Nevertheless, we argue that children’s perspectives must be considered as much as possible while designing SG. If not by direct involvement in the designing process (in a Participatory Design approach, for instance), at least by considering relevant guidelines such as the ones we compiled here.

Future work includes expanding the validation to non-Portuguese speakers and building an instrument that would facilitate including, excluding and updating the guidelines by SG designers and researchers.

ACKNOWLEDGMENT

<Omitted for blind review>

REFERENCES

- [1] H. Hsiao. “A Brief Review of Digital Games and Learning”. First IEEE International Workshop on Digital Game and Intelligent Toy Enhanced Learning (DIGITEL’07), 2007, pp. 124-129. doi: 10.1109/DIGITEL.2007.3.
- [2] N. Balasubramanian, B. G. Wilson, and K. J. Cios. “Innovative methods of teaching science and engineering in secondary schools.” *System, Cybernetics and Informatics*, vol. 4, num. 6, 2006, pp. 41-46. ISSN: 1690-4524.
- [3] D. B. Cone, et al. “Cyber security training and awareness through game play.” *Security and Privacy in Dynamic Environments. SEC 2006*. vol. 201, pp. 432-436. doi: 10.1007/0-387-33406-837
- [4] J. Kirriemuir, and A. Mcfarlane. “Literature Review in Games and Learning”. A NESTA Futurelab Research report, vol. 8, 2004.
- [5] B. Gros. “Digital games in education: The design of games-based learning environments.” *Journal of Research on Technology in Education*. vol. 40, num. 1, 2007, pp. 23-38.
- [6] S. S. VanDeventer, and J. A. White. “Expert behavior in children’s video game play.” *Simulation & Gaming*, vol 33, num. 1, 2002, pp. 28-48.
- [7] G. A. M. Falkembach. “O lúdico e os jogos educacionais.” *CINTED-Ciclo de Palestras sobre Novas Tecnologias na Educação*, 2006. (In Portuguese)

- [8] M. Prensky. "Digital natives, digital immigrants part 1." *On the Horizon*, vol. 9, num. 5, 2001, pp. 1-6.
- [9] R. Savi and V.R. Ulbricht. "Jogos digitais educacionais: benefícios e desafios." *RENOTE - Revista Novas Tecnologias na Educação*, vol. 6, num. 2, 2008. ISSN 1679-1916. (In Portuguese).
- [10] J. C. Read, and P. Markopoulos. "Child-computer interaction." *International Journal of Child-Computer Interaction*, vol. 1, num. 1, 2013, pp. 2-6.
- [11] J. C. Read, and M. M. Bekker. "The nature of child computer interaction". *Proceedings of the 25th BCS conference on Human-Computer Interaction*, 2011, pp. 163-170.
- [12] J. P. Hourcade. "Interaction design and children". *Foundations and Trends in Human-Computer Interaction*, vol. 1, num. 4, 2008, pp. 277-392.
- [13] S. Chiasson, and C. Gutwin. "Design principles for children's technology". *Interfaces*, vol. 7, 2005, pp. 28.
- [14] C. Mariage, J. Vanderdonckt, and C. Pribeanu. "State of the art of web usability guidelines". *The handbook of Human Factors in Web Design*, 2005, pp. 688-700.
- [15] A. Herrington., J. Herrington, and J. Mantei. "Design principles for mobile learning". *New Technologies, New Pedagogies: Mobile Learning in Higher Education*, 2009, pp. 129-138.
- [16] J. Nielsen. "Alertbox: 'Kids' corner: Website usability for children.", 2002.
- [17] M. O. Leavitt, and B. Shneiderman. "Based Web Design & Usability Guidelines". *Background and Methodology*, 2006. ISBN 0-16-076270-7.
- [18] T. Nousiainen, and M. Kankaanranta, "Exploring Children's Requirements for Game-Based Learning Environments". *Advances in Human-Computer Interaction*, vol. 2008, Article ID 284056, 7 pages, 2008.
- [19] K. Chorianopoulos, M. N. Giannakos, and N. Chrisochoides. "Design principles for serious games in mathematics." *Proceedings of the 18th Panhellenic Conference on Informatics*, 2014, pp 1-5, doi: 10.1145/2645791.2645843.
- [20] T. P. Falcão and R. Barbosa. "Aperta o Play! análise da interação exploratória em um jogo baseado em pensamento computacional." *Simpósio Brasileiro de Informática na Educação - SBIE*, vol. 26, num. 1, 2015. (In Portuguese).
- [21] K. Inkpen. "Three important research agendas for educational multimedia: Learning, children, and gender". *AACE World Conference on Educational Multimedia and Hypermedia*, vol. 97, 1997, pp. 521-526, doi: 10.1.1.89.6739.
- [22] M. Bernard, et al. "Which fonts do children prefer to read online". *Usability News*, vol. 3, num. 1, 2001.
- [23] A. Bruckman, and A. Bandlow. "Human-computer interaction for kids". In Julie A. Jacko and Andrew Sears, editors, *The Human-Computer Interaction Handbook*, L. Erlbaum Associates Inc., 2003, pp. 428-440.
- [24] D. F. P. Vasconcelos, et al. "The protocol of a serious game based on Virtual Reality to aid in the literacy of children with Intellectual Disability." *Simpósio Brasileiro de Jogos e Entretenimento Digital*, 2017, ISSN: 2179-2259. (In Portuguese).
- [25] R. Rosas, et al. "Beyond Nintendo: design and assessment of educational video games for first and second grade students." *Computers & Education*, vol. 40, num. 1, 2003, pp. 71-94.
- [26] F. R. F. Lopes. "Software educativo, lúdico e interativo, como recurso didático em apoio à construção do conceito de número por crianças em processo de alfabetização matemática". *Universidade de Brasília (UnB) – Programa de Pós-Graduação em Educação (PPGE)*, 2015. (In Portuguese).
- [27] L. Hanna, et al. "The role of usability research in designing children's computer products". *The design of children's technology*. Morgan Kaufmann Publishers Inc., 1998.
- [28] R. Pausch, V. Vogtle, and M. Conway. "One dimensional motion tailoring for the disabled: A user study." *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 1992, pp. 405-411, doi: 10.1145/142750.142876.
- [29] A. R. Pereira, and A. P. P. M. Peruzza. "Tecnologia de Realidade Virtual Aplicada à Educação Pré-Escolar." *Brazilian Symposium on Computers in Education (Simposio Brasileiro de Informatica na Educação - SBIE)*, 2002, pp. 385-391. (In Portuguese).
- [30] I. Gasparini, M. F. Carvalho, and M. da S. Hounsell. "Jogos Digitais para Alfabetização Matemática: Um Mapeamento Sistemático da Produção Brasileira." *SBGames: Simpósio Brasileiro de Jogos e Entretenimento Digital*, 2015, pp. 430-437, ISSN: 2179-2259. (In Portuguese).
- [31] S. Voytilla, and C. Vogler. *Myth & the Movies: "Discovering the myth structure of 50 unforgettable films"*. Michael Wiese Productions, 1999.
- [32] N. Nasiri, S. Shirmohammadi, and A. Rashed. "A serious game for children with speech disorders and hearing problems." *Serious Games and Applications for Health (SeGAH)*, 2017, pp. 1-7.
- [33] E. Strommen. "When the interface is a talking dinosaur: learning across media with ActiMates Barney." *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 1998, pp. 288-295, doi: 10.1145/274644.274685.
- [34] J. Stewart, et al. "When two hands are better than one: Enhancing collaboration using single display groupware." *CHI 98 conference summary on Human Factors in Computing Systems*, 1998, pp. 287-288, doi: 10.1145/286498.286766.
- [35] K. S. Tekinbas, and E. Zimmerman. "Rules of play: Game design fundamentals." MIT press, 2004.
- [36] M. Zyda. "From visual simulation to virtual reality to games." *Computer*, vol. 38, num. 9, 2005, pp. 25-32.
- [37] E. Tse, et al. "Child computer interaction: workshop on UI technologies and educational pedagogy." *CHI'11 Extended Abstracts on Human Factors in Computing Systems*, 2011, pp. 2445-2448.
- [38] A. Druin, et al. "Designing a digital library for young children." *Proceedings of the 1st ACM/IEEE-CS joint conference on Digital Libraries*, 2001, pp. 398-405, doi: 10.1145/379437.379735.
- [39] K. E. Steiner and T. G. Moher. "Graphic StoryWriter: An interactive environment for emergent storytelling." *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 1992, pp. 357-364.
- [40] S. L. Halgren, T. Fernandes, and D. Thomas. "Amazing animation: movie making for kids design briefing." *Proceedings of the SIGCHI conference on Human Factors in Computing Systems*, 1995, pp. 519-525, doi: 10.1145/223904.223974.
- [41] T. Jones. "Recognition of animated icons by elementary-aged children." *Research in Learning Technology*, vol. 1, num. 1, 1993, pp. 40-46.
- [42] K. G. Schneider. "Children and information visualization technologies". *Interactions*, vol. 3, num. 5, 1996, pp. 68-73.
- [43] S. Gilitz. "Usability of Websites for Children: 70 design guidelines based on usability studies with kids". *Nielsen Norman Group Report*, 2002.
- [44] N. S. Said. "An engaging multimedia design model." *Proceedings of the 2004 conference on Interaction design and children: building a community (IDC '04)*, 2004, pp. 169-172, doi: 10.1145/1017833.1017873.
- [45] J. C. Lester, S. A. Converse, S. E. Kahler, S. T. Barlow, B. A. Stone, and R. S. Bhogal. "The persona effect: affective impact of animated pedagogical agents". In *Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems (CHI '97)*, 1997, pp. 359-366, doi: 10.1145/258549.258797.
- [46] L. Xie, A. N. Antle, and N. Motamedi. "Are tangibles more fun?: comparing children's enjoyment and engagement using physical, graphical and tangible user interfaces". *Proceedings of the 2nd international conference on Tangible and Embedded Interaction (TEI '08)*, 2008, pp. 191-198, doi: 10.1145/1347390.1347433.
- [47] OMITTED FOR BLIND REVIEW
- [48] OMITTED FOR BLIND REVIEW

TABLE 1. LIST OF GUIDELINES AND THEIR AGREEMENT, CLEARNESS, IMPORTANCE AND RELEVANCE GATHERED FROM RESPONDENTS

GUIDELINE	Agree	Clear		Important		RELEVANCE	SOURCE
		μ	sd	μ	sd		
G_1 : Simplify the use of the mouse	8,64	8,64	1,66	8,63	2,18	8,64	[23], [34], [13], [38], [12]
G_2 : Avoid differentiate between left and right	8,47	8,42	1,55	8,53	2,19	8,47	[23], [33]
G_3 : Use efficient interaction mechanisms with interface elements	10,00	8,78	1,57	9,32	2,21	9,37	[13], [38], [37], [12], [39]
G_4 : Allow spoken instructions	9,32	9,41	1,57	9,17	2,22	9,30	[24], [26]
G_5 : Hide features of advanced levels	9,15	9,15	1,58	8,93	2,23	9,08	[23], [40]
G_6 : Explore cooperative use	8,47	7,98	1,59	8,07	2,25	8,18	[21]
G_7 : Use font type that ease reading	9,32	9,39	1,60	9,46	2,27	9,39	[23], [22], [24], [18]
G_8 : Relate interface metaphor to children world	8,98	7,88	1,61	8,58	2,28	8,48	[23], [41], [40], [42], [20], [13], [38], [18]
G_9 : Make interaction elements ease to spot	9,32	9,17	1,62	9,34	2,30	9,28	[23], [43], [30]
D_{10} : Use appropriate interaction time to children's age	9,66	8,90	1,63	9,12	2,32	9,23	[37]
G_{11} : Use meaningful icon as a replacement or help to texts	10,00	9,47	1,65	9,59	2,34	9,69	[13], [37], [27]
G_{12} : Prefer recognizing than remembering	9,83	8,10	1,67	9,17	2,35	9,03	[20], [32]
G_{13} : Use visual interface mainly	9,49	9,25	1,68	9,44	2,36	9,40	[13], [38], [30], [24]
G_{14} : Provide accurate and fast feedbacks	9,83	9,41	1,69	9,58	2,38	9,60	[20], [13], [39], [44]
G_{15} : Show clearly the status of the system	10,00	9,22	1,55	9,41	2,31	9,54	[13], [27], [18]
G_{16} : Prefer to use characters for interaction	9,15	8,76	1,56	8,53	2,33	8,81	[13], [27], [45]
G_{17} : Present information to users according to their level of development	9,66	8,73	1,56	9,20	2,34	9,20	[12]
G_{18} : Use interfaces and conventions that are already known by the users	9,49	9,25	1,58	9,17	2,37	9,31	[18], [25]
G_{19}: Layout must be rich in content with little empty spaces	5,59	8,31	1,59	7,03	2,39	6,98	[18]
G_{20} : Present scoring and/or classification as clear as possible in screen	9,49	9,14	1,49	9,20	2,41	9,28	[18]
G_{21}: Interface must look and behave as real as possible	4,07	8,42	1,51	6,59	2,42	6,36	[20], [18]
G_{22} : A great variety of themes/skins must be available	8,31	9,02	1,52	7,98	2,44	8,44	[18]
G_{23} : Information must be presented in more than one way	8,98	8,34	1,32	8,41	2,46	8,58	[26]
G_{24} : Reward the player	10,00	9,29	1,33	9,66	2,50	9,65	[13], [27], [28]
G_{25} : Devise a way to emphasize clickable interface elements	9,32	9,10	1,31	9,14	2,53	9,19	[13], [27]
G_{26} : Documentation and Help must be objective and easy to find	8,81	9,19	1,32	8,19	2,55	8,73	[20], [46]
G_{27} : Allow players to undo and correct mistakes	9,49	9,39	1,33	9,19	2,57	9,36	[19]
G_{28} : Allow user to explore the system and build things	9,15	9,10	1,34	8,61	2,61	8,95	[18]
G_{29} : Logically scaffold the content	9,49	8,71	1,35	9,31	2,65	9,17	[29] [30]
G_{30} : Fit vocabulary to target audience	10,00	9,51	1,36	9,71	2,33	9,74	[29]
G_{31} : Fit the game to user's level of experience	9,49	9,17	1,36	9,54	2,35	9,40	[13], [27], [45]
G_{32} : Design interesting and challenging activities	10,00	9,17	1,39	9,58	2,30	9,58	[13], [27], [24]
G_{33} : Teachers must be able to configure the game accordingly if the game is to be assisted by them	9,49	9,17	1,40	8,68	2,34	9,11	[29], [30]
G_{34} : Accidentally embed target content in the game	8,31	8,36	1,42	8,75	1,97	8,47	[25]
G_{35} : Use narratives/stories to engage players	9,83	9,08	1,45	8,80	1,40	9,24	[19][31]
G_{36} : Clearly define goals	9,49	9,54	1,08	9,49	1,41	9,51	[19] [29] [27]
G_{37} : Avoid too much attention and concentration loads	8,98	9,47	1,08	9,03	1,44	9,16	[32]
G_{38} : Allow many different levels of the game	8,81	8,24	1,09	8,15	1,14	8,40	[29], [30]
G_{39} : Show players' tracks (already visited places and contents)	9,15	8,90	1,09	8,95	1,12	9,00	[33], [13]
G_{40} : Teachers must be able to control the game while running if the game is to be assisted by them	8,98	9,36	1,09	8,58	1,14	8,97	[12]