

# The co-design of educational video games

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**Abstract.** Co-design is a widely implemented practice in many areas of design, from software and industrial engineering to the applied arts. It deliberately and systematically incorporates the ideas, knowledge, and interests of stakeholders into the design of an artefact. Contemporary co-design practices in the context of educational video games (EVGs) exist. However, the professional and academic literature gives insufficient insight into how these practices are structured to improve the design process. This research aims to resolve that gap by answering the following questions: (1) How are the co-design practices of contemporary EVG companies structured? (2) Who are the relevant stakeholders of EVGs for children of primary education? (3) How are those stakeholders involved in the design process? (4) How do stakeholders influence game design elements (GDEs) of EVGs? Twelve semi-structured interviews with educational game designers from international companies were conducted to answer those questions. Interviewees are asked to describe their co-design practices, define stakeholders, and explain how they are involved. Interviewees are then invited to participate in a hierarchy-building exercise to explore how stakeholders influence specific GDEs, thereby impacting the game's design. After systematically exploring the influence of the defined stakeholders, the data collected from the ranking and hierarchy exercises were aggregated and contrasted with the interviews for interpretation. The results show that most co-design practices are similarly structured but display varying degrees of stakeholder involvement. While stakeholders and their influence on GDEs can vary across projects, some consistencies were found. The authors recommend following the three identified co-design stages, involving at least four of the five types of stakeholders, and systematizing co-design processes for a better design and more efficient use of resources. Further research on co-design could improve their systematic design and improve EVGs in the many fields where they can be applied, from cultural contexts and healthcare to formal education.

**Keywords:** Educational Video Games, Game-Based Learning, Game Design, Co-Design, Stakeholder involvement.

## 1 Introduction

EVGs can be distinguished by their primary design purpose. Commercial off-the-shelf games may occasionally deliver educational content, but their design prioritizes fun over learning [1]. Purely educational games, on the other hand, prioritize learning

over fun. Researchers have identified primary education as the most appropriate age to integrate EVGs due to several reasons, primarily due to the positive attitude educators have towards games and the flexibility of their curricula [2]. Therefore, this study focuses on the co-design of purely educational games for children within the age range of primary education, between 6 and 12 years.

The term co-design commonly conceptualizes collaborative design by involving parties from outside of a design and development team [3]. Sužnjević & Homen explain how the needs and demands of students and educators should be met during the development of EVGs because it could transform serious games in education both in innovation and acceptance. [4] Their involvement in the design process effectively makes them co-creators and thereby become a type of stakeholder.

To validate contemporary design practices and ensure the quality and positive impact of future EVGs, it is essential to review the applied methods. While most serious game companies that develop EVGs claim to practice co-design with stakeholders, they provide no documentation of their practices. Additionally, no frameworks for co-design in the context of EVGs are publicly available nor seem to exist. This knowledge gap drives this research to explore contemporary co-design practices. The objective is to amend this shortcoming by studying how co-design is being practiced by companies that develop EVGs to provide an initial framework for co-design in this context.

## **2 Study Design**

### **2.1 Research questions**

To start closing this knowledge gap, the following questions were designed to (1) understand the structure of co-design practices, (2) how stakeholders are being identified, (3) involved in the design process, and (4) influencing game design elements within contemporary EVG companies.

**RQ-1:** How are co-design practices structured?

**RQ-2:** Who are the stakeholders of EVGs for children?

**RQ-3:** How are they being involved in their design process?

Through semi-structured interviews with open questions, qualitative data is collected from educational game designers. Asking how they would define terms and processes of, i.e., co-design or stakeholder involvement, gives interviewees the freedom to explain how these are conceptualized and structured within the companies workflow. Follow-up questions on specific aspects, such as stakeholder prioritization or involvement methods, are asked when more detail is needed.

Answering the first research question will give an overview of their co-design practices and structure. It is essential for a collaboration to understand who the participants are and how they are involved. The second and third questions aim to provide insight into how stakeholders are identified and involved. However, EVGs are expected to be diverse in nature and purpose, leading them to require a specific constellation of stakeholders. In anticipation of this problem, a fourth question is asked to systematize the co-design process.

**Research Question 4:** How do stakeholders influence game design elements (GDEs)?

GDEs are components or aspects of a game that can be conceptualized differently. Exploring how different stakeholders influence specific GDEs during the collaboration appears not to have been done before. It could highlight useful trends for a more generalized and structured co-design practice. This research uses GDEs proposed by three different authors [2,5,6] to accommodate game designers with potentially different perspectives.

To explore how stakeholders influence GDEs, a gamified exercise of custom design was used to engage game designers during the online interviews. This digital application first asked participants to define and rank a maximum of five stakeholders, according to how strongly they believed them to influence game design choices in the context of a specific game. However, participants often used examples of other games they had made to compare and exemplify their arguments. After defining stakeholders, participants were asked to build a six-piece pyramidal hierarchy of influence (Figure 1) to illustrate how strongly a specific stakeholder influenced those GDEs. This exercise was systematically performed for all defined stakeholders in decreasing order of their ranking. While performing this task, the interviewer requested explanations on these hierarchies to understand better how stakeholders influenced the design process.



**Fig. 1.** In-game screenshot: Hierarchy of influence. Example response from an interviewee.

This exercise provides qualitative data on how stakeholders influence the game design process while collecting quantitative data from their responses. Based on their placement within the hierarchies of influence, GDEs are assigned values. This mixed-method is exploratory, but if the quantitative and qualitative data coincide across interviewees, they may indicate relevant relationships that would aid the design of a systematic approach for the stakeholder involvement process.

## **2.2 Data collection**

Twelve interviews were conducted with experienced educational game designers from eleven different companies from six countries (Netherlands, Denmark, Portugal, Peru, Indonesia, and United States). Enlisting these participants during the COVID-19 pandemic was a challenge. Over 40 serious game companies that also design EVGs were sought out and contacted over their websites, emails, and social media. The majority of companies did not respond or declined. After almost four months, the twelve interviews were recorded.

Most companies within this sample are small; seven out of twelve companies consisted of five or fewer employees. In those cases, the game designer would also be the CEO, business developer, creative director, programmer, researcher, or project manager of the company. Those interviews granted access to both a perspective on their game design process and details on overarching company procedures and philosophies in one single interview. On the other hand, larger companies would have more specialized roles for their team members, leading to potential limitations in their knowledge. We attempted to mitigate these discrepancies by interviewing different profiles within larger companies when necessary to ensure we get sufficient insight into company philosophies regarding co-design and their procedures. 2 interviewees were unfamiliar with the nuances of their companies' design practices. They were not asked to use the application relating to the fourth question, resulting in 10 participants.

## **2.3 Limitations**

Our research is constrained by limitations that are intrinsic to qualitative studies, such as the interpretation of statements and opinions. Interviewees' responses are limited to their perception of company processes and co-design practices and may not be entirely accurate. Cultural differences and ambiguity in expressions or terminology across our international sample of interviewees could also distort the data and influence the interpretation of qualitative data. Additionally, the quantitative data collection method is exploratory, uses arbitrary values, and has not been thoroughly tested to guarantee conclusive statistical data.

### **3 Results**

#### **3.1 Contemporary co-design practices**

Interviews revealed that co-design practices across companies are structured in a relatively similar way. One difference can be found in their business model. Most EVGs are commissioned by clients with specific goals. They occasionally also pitch projects to potential clients. In a few cases, EVGs are developed first and then offered to educational institutions or sold as commercial games. However, this practice was described by interviewees as risky and unsustainable, having a limited impact on users and offering fewer possibilities of collaboration with stakeholders. From our sample, 8 out of 11 companies work under commission, while the others were less committed to a business model or co-design process.

Companies working with clients always start with the scoping process, which takes place once a project has been commissioned or a pitch greenlit by a client. It is considered the first step in co-design and aims to define a set of parameters for the project. One company employs a questionnaire to mainly establish the target audience, context, goal, the desired change in behavior, and how it can be measured, among other parameters. While larger companies tend to have systems in place for this process, smaller companies conduct a less structured approach.

Once the scope is defined, most companies request a list of relevant stakeholders for the project. Game designers engage these stakeholders in an iterative process often described as two separate stages, design and testing. These are reported to overlap and intertwine until the game is considered polished. However, designers did not present a specific structure or list of stakeholders they require for this iterative process. Only one larger company reports profiling stakeholders for a strategic approach.

#### **3.2 Stakeholder involvement**

Game designers generally acknowledge the benefits of collaborating with stakeholders to design a game with a measurable impact. However, interviews reveal mixed opinions on how extensively they like to involve stakeholders. Most companies prefer having less interaction with stakeholders. One interviewee explains how clients tend to be fixated on ideas or introduce biases, which leads to difficult conversations that often end in disappointment or frustration. Smaller companies tend to have fewer resources to manage these situations and prefer having more control over the creative design. They can cost time and negatively affect the relationship with their client and their reputation in the market. One of the smaller companies developed a gamified application that quantitatively samples their stakeholders' preferences on features for the project. With this method, they can quickly settle disputes and let the data guide their design process, reducing the need for recurring meetings with stakeholders.

Some designers also reported experiencing difficulties managing the expectations of multiple stakeholders with opposing opinions. Conflicts of interest among stakeholders, which the team was not equipped to handle, often created unexpected tension and, in one case, led to a situation where the client had to intervene and dictate the resolution.

Companies that prefer more hands-on involvement from their stakeholders briefly mention the use of specialized workshops and brainstorming techniques that can last between 5-6 hours and are said to enhance the team spirit. However, they require resources and time that not all companies, clients, or stakeholders have or are willing to allocate.

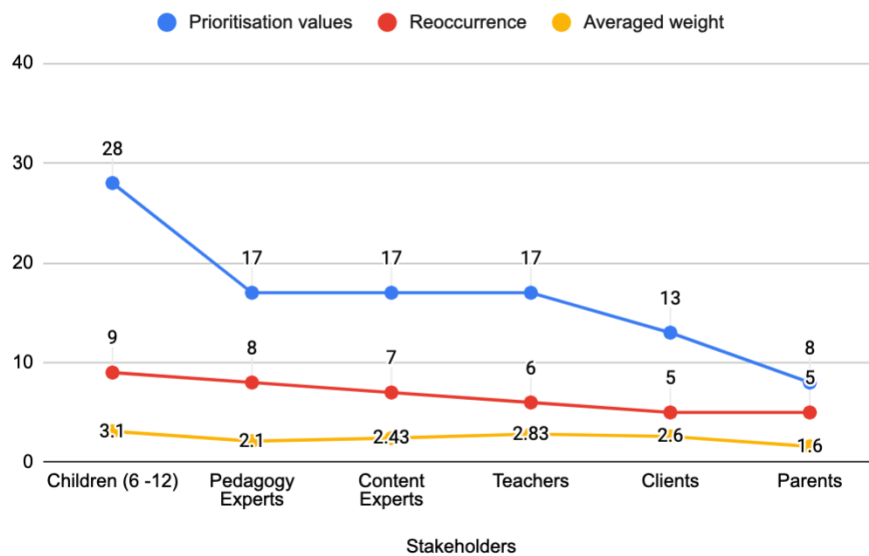
As stakeholders, clients seem to be most involved at the beginning of the project, during the scoping stage, after which their involvement declines. On the other hand, the other stakeholders are brought in soon after the scoping process, some for the design stage and others for the testing stage. Each stakeholder seems to have a place within the co-design process, which varies based on their role and depends on the scope and context of the EVG. Additionally, different types of stakeholders were identified across interviewees. Not all were always considered relevant to all projects. In the case of a mathematics or programming game, designers did not feel the need to involve content experts as some of their team members could fulfill that role. One of the interviewees was an instructional designer, who may generally fulfill the role of a pedagogy expert. In other cases, many unexpected kinds of stakeholders for EVGs emerged that were specific to a project, its learning objectives, context, and the needs of their designers. Some examples were healthcare professionals who care for children with asthma and are familiar with their condition, psychology researchers who study how to improve children's performance with attention deficit disorders, or another case, where a client and a venue were presented as two different clients with different needs and interests.

To avoid the splintering of stakeholders, and to systematize the stakeholder involvement, emergent stakeholders were categorized into groups. These were defined based on the roles they played; (1) *content experts* include subject matter specialists, curriculum coordinators, and researchers who provide knowledge on the subject and guide the content creation of the game, while (2) *pedagogy experts* include freelance consultants, researchers, healthcare professionals and psychologists who would guide the pedagogical aspects of the game. Researchers, i.e., could play either role depending on their research. Interviewees' explanations were essential to guide the interpretation of their roles within their specific contexts for the most appropriate categorization. This grouping is therefore contextual, non-exclusive, and potentially biased by interpretation. Six stakeholder groups were identified across the ten game designers that defined forty-two stakeholders.

### **3.3 Stakeholder prioritization**

The quantitative data collected from the application symbolizes the influence of stakeholders on game design elements. Only two of the ten interviewees who participated in this exercise defined five stakeholders, while all others defined four. Those fifth stakeholders were discarded to homogenize the collected responses so that only four would be taken into account per participant. Higher ranking stakeholders are considered to have a higher priority in terms of influence in the game design process. The highest ranking would receive 4 points to numerically represent this, while the lowest would only receive 1 point. Each interviewee would thereby be assigning 10

points to different stakeholders, adding up to 100 points. Their rankings were added individually to quantify their accumulated weight within this sample, labeled as their prioritization values. Figure 2 shows all stakeholder groups arranged in order of these values, which coincide with their reoccurrence, referring to how often they were included as stakeholders by game designers. Only two stakeholders were discarded, leaving the total points in reoccurrence at 40.



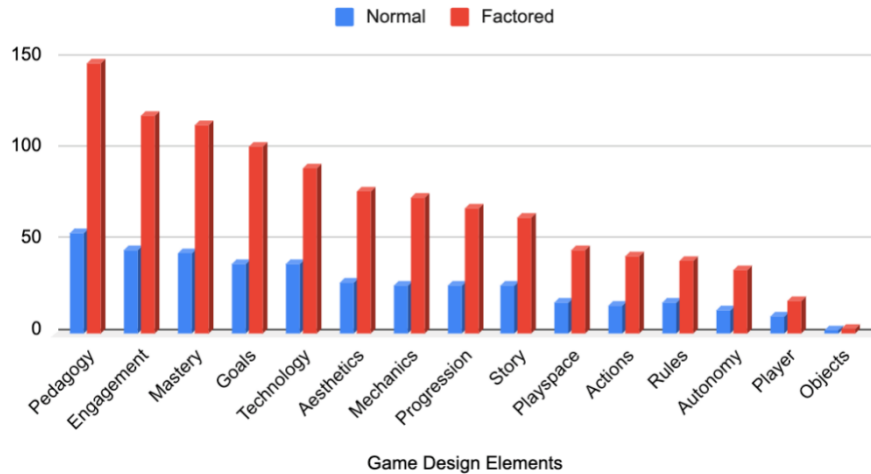
**Fig. 2.** Stakeholder ranking.

The mean average weight is calculated by dividing the prioritization values by their reoccurrence. It averages the influence stakeholders generally have in co-design practices within this sample. Teachers, pedagogy, and content experts, for instance, have the same amount of prioritization points and explains why their average weight inversely mirrors the decrease in reoccurrence. Teachers are therefore more likely to influence design choices within a game than pedagogy experts. However, it is important to note that this can shift dramatically from project to project according to their context. For example, if the EVGs were designed to be used outside the context of a class, teachers may not be involved at all.

### 3.4 Stakeholder influence

From the application data, it can also be estimated which GDEs are most likely influenced by stakeholders. Based on their placement within the hierarchies of influence (Fig. 1), they are assigned a symbolic value. The top pyramid tier gives 3 points, then 2 and finally 1. These accumulate over entries and show which GDEs are most influenced by stakeholders. Multiplying them with the stakeholders' prioritization points from their corresponding hierarchy of influence allows their relative weight to be

factored in for more distinctive results. Figure 3 displays both of these accumulated values for all GDEs, normal and factored, and arranged by factored values. The graph reveals a relatively steady curve of decline, which is mirrored by the normal values, with very few discrepancies.



**Fig. 3.** Most influenced GDEs during co-design.

In response to the fourth research question, the following graphs show how strongly the identified groups of stakeholders influence individual GDEs. Stakeholders will be reviewed in descending order of reoccurrence. For consistency, the order of GDEs along the x-axis in Figure 3 remain consistent throughout all subsequent graphs. However, the y-axis will be lower to accommodate a smaller range of values and remain consistent thereafter.

Due to the small sample size and exploratory nature of the quantitative data, it is relevant to note that there is low reliability in these numbers. Strong outliers are only considered indicative if the qualitative data supports them. Under these conditions, GDEs may be potentially relevant in the context of a specific stakeholder. These findings may guide the design of a systematic stakeholder involvement method.

**Children.** As stakeholders, children have the most substantial influence on the engagement, aesthetics and mechanics of EVGs. Figure 4 displays these three GDEs as distinctive quantitative outliers in the context of children as stakeholders. Game designers generally emphasized them during the interviews. However, aesthetics and mechanics seemed to work in function of engagement. One interviewee expressly focuses on their efforts of appealing to children or drawing their attention for engagement. During the design and testing stage, they “[...] try to see whether this style of animation or this storyline is appealing for them and those are very iterative processes.” Aesthetics are often portrayed as an efficient method of engaging children with the game. However, this is not considered an easy task and must be extensively



iterated. Another game designer also acknowledges the importance of aesthetics and elaborates on the challenges they encountered measuring the impact of aesthetics on children. “[...] You can’t ask them ‘hey, do you like how this is drawn?’ - They’ll have an emotional connection with the picture, depending on what the picture depicts and not depending on the art style. [...] They could like a specific image with some art style, but then they would have preferred maybe the other art style if we’d continued with the other one. It’s hard to measure.” Many other game designers share similar experiences, and some report relying on parents or guardians to help children convey their feedback more accurately.

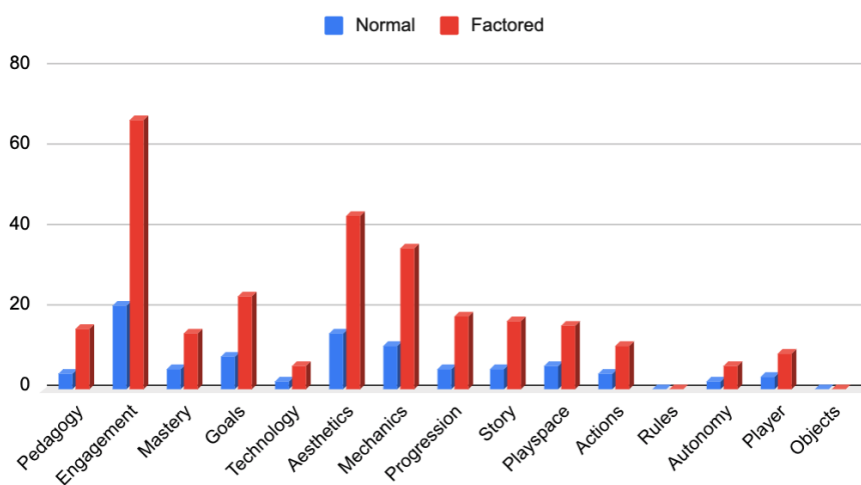


Fig. 4. GDEs most influenced by children.

Some game designers also mention their occasional reliance on mechanics as a method of keeping children engaged. Game mechanics would seem to be a more intuitive and less challenging method of engagement, unlike aesthetics.

**Pedagogy experts.** The GDE pedagogy is the most influenced by this stakeholder, as shown by Figure 5. However, while pedagogy experts are only one point below children in reoccurrence, it is relevant to consider that their accumulated points are much lower. As these decrease, outliers become more challenging to identify, for which the reliance on qualitative data becomes more important. Pedagogy is the main outlier of this graph and supported by qualitative data. This stakeholder group is defined by its role in the pedagogical design of EVGs. To be specific, one interviewee explains how they have “[...] their own ways of teaching and we do not want to block that. [...] We want to enhance their ways and that’s one of the most important things.” Thereby illustrating how strongly they can influence the pedagogical aspect of the game.

To a lesser degree, the GDEs mastery, goals and rules were often discussed in the context of learning objectives and pedagogy of a game. However, due to their more

ambiguous result in the application, only goals will be considered a distinctive yet ambiguous GDE in the context of pedagogy experts.

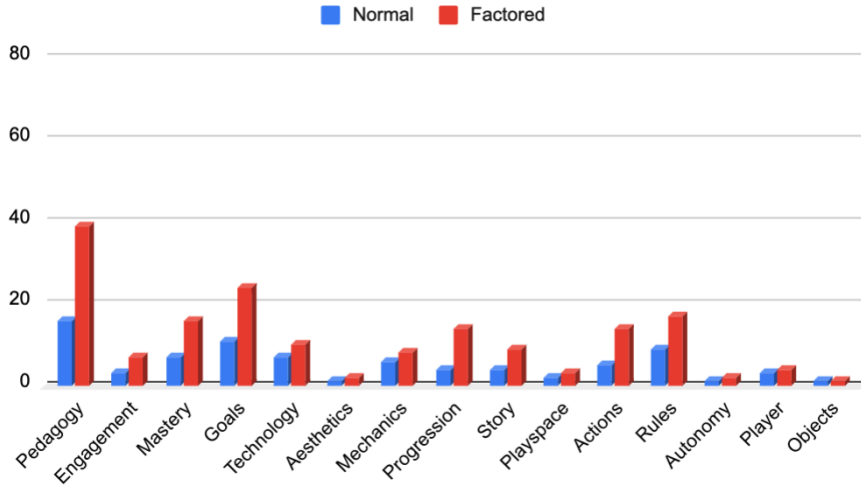


Fig. 5. GDEs most influenced by pedagogy experts.

**Content experts.** The influence of content experts in Figure 6 is spread out across many GDEs, resulting in a far too ambiguous graph that does not show distinctive outliers. It is possible that the content of an EVG consistently influences most GDEs or that the ambiguity could be resolved by analyzing examples by topic; STEM, history, language, etc. Further research could resolve this.

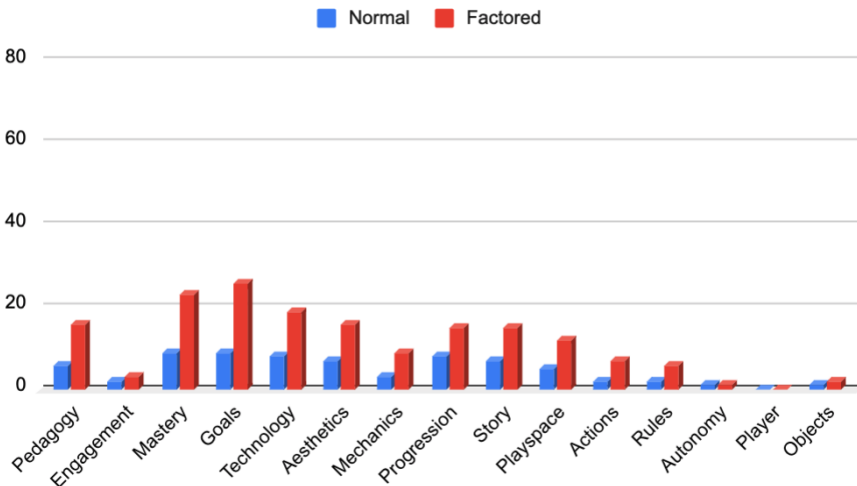
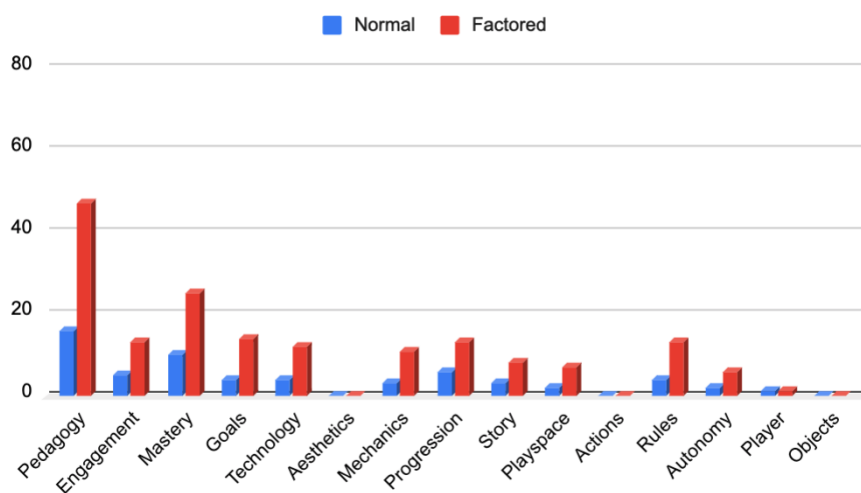


Fig. 6. Most influenced GDEs by content experts.

**Teachers.** Similar to pedagogy experts, teachers have a strong influence on the pedagogical design of the game, almost exclusively when the EVG is being designed for a classroom. This coincides with Figure 7 that displays pedagogy as the most distinctive outlier of the graph. Unlike pedagogy experts, teachers seem more influential due to their role as facilitators by employing the game within a classroom. They may have a lower reoccurrence than pedagogy experts within the presented sample, yet they rank higher, increasing their average weight of influence. They are effectively users and are therefore more influential than most stakeholders and often included in the game's design and testing stage.



**Fig. 7.** Most influenced GDEs by teachers.

When discussing the other GDEs, some game designers briefly referred to mastery, goals, and progression as other relevant factors that teachers often want to influence. However, only mastery is quantitatively distinctive enough to be considered a potentially consistent GDE that teachers influence. Yet this is only true for games designed in the context of a class.

**Clients.** When included, clients tend to be influential in defining the technology and, to a lesser extent, pedagogy of a game. Their primary role seems to be to determine the general scope and context of the project. Figure 8 reflects their distinctive influence on the technology for which the game needs to be developed, corresponding to its context. According to game designers, the learning objectives also tend to be defined by the client. Learning goals are often the motivator of a project, and while the clients are not necessarily pedagogy experts, they sometimes prefer to remain involved.

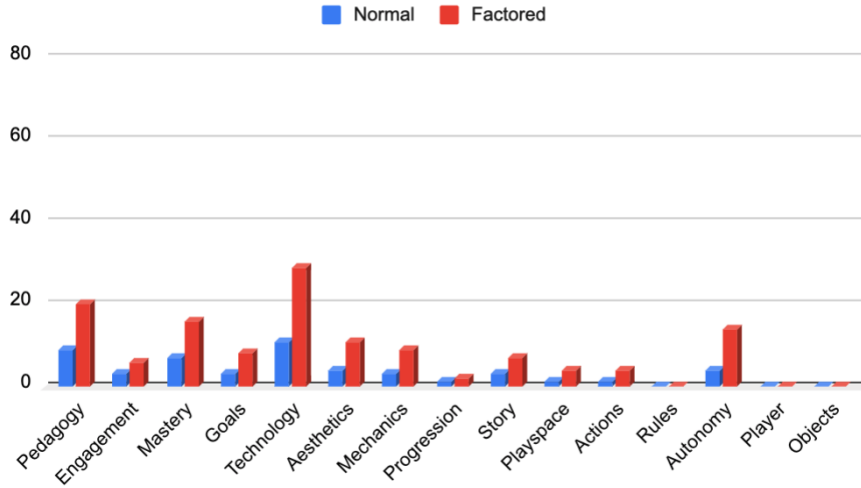


Fig. 8. Most influenced GDEs by clients.

**Parents / guardians.** The least prioritized stakeholder group is rarely involved and almost exclusively considered a facilitator for children who play EVGs at home. With the lowest scores on all accounts, parents have the most ambiguous result. Figure 9 seems to indicate engagement, mastery and technology as potential candidates, but the qualitative data is insufficient to support this. A larger sample of games that include parents as stakeholders would be needed to obtain clearer results.

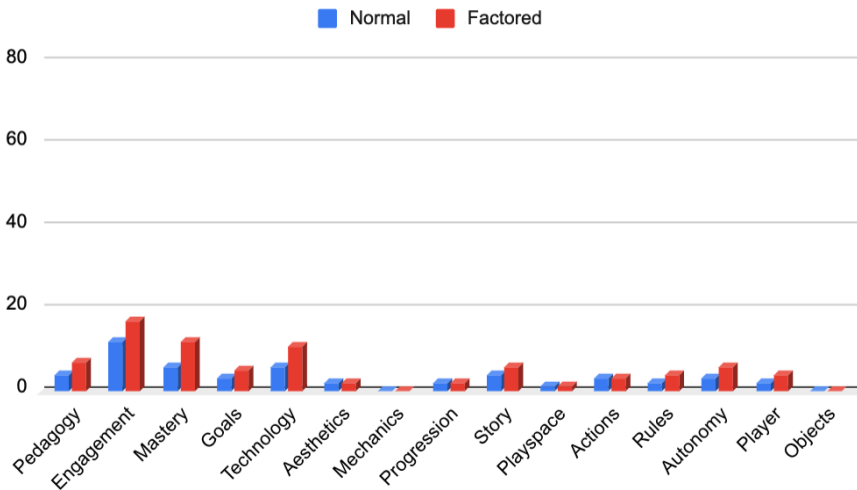


Fig. 9. Most influenced GDEs by parents/guardians.

## **4 Discussion**

### **4.1 Co-Design**

Most contemporary serious game companies that make EVGs seem to have developed similar co-design practices. These can be divided into three stages; (1) the scoping process, where the purpose and context of the game are defined, (2) the co-design stage, where stakeholder are differently involved, and the (3) testing stage, where users and facilitators test prototypes until the product is ready for delivery. While the first and second stages are separate, the second and third stages initially overlap in an iterative cycle, as different aspects of the game are adjusted. This structure likely evolved by mimicking the flexible and iterative nature of game design and is, therefore, in a general sense, appropriate.

According to experienced game designers, involving stakeholders is essential because it improves the effectiveness and quality of the content and its appeal and practical application within the intended context. However, this study did not identify any indicators that the process of extensive and hands-on collaborations is indispensable to achieve these results. As long as stakeholders are thoroughly sampled for their input, the collaboration can be sufficient. Therefore, small companies should develop tools that aid them in their data collection from stakeholders and systematize their collaboration efforts. This can reduce the amount of time and resources needed. On the other hand, larger companies may choose to do the same or lead more hands-on collaborations.

### **4.2 Stakeholders**

Stakeholder interaction starts with the client, and the subsequent definition of stakeholders for their involvement in the co-design process has exclusively relied on the client. However, four stakeholder roles have been consistent throughout the examined projects; The client itself, the end-user, content and pedagogy experts. It would be advisable for game designers to require these stakeholders from their clients for their co-design practices.

Occasionally, depending on the context, facilitators may be included. In which case, they are likely to be parents, guardians, teachers, or healthcare practitioners. There may exist a preference of game designers to prioritize facilitators over other stakeholders. Despite teachers and pedagogy experts ranking as relatively influential, parents or guardians are the lowest. This preference is likely dependent on how relevant the facilitator is in the context of the game, or how closely they resemble a type of user. More research would be required to establish the nuances of this observation.

Table 1 presents a summary of the findings regarding stakeholder influence on GDEs. They have been arranged by their occurrence in co-design stages, effectively providing a layout of stakeholder involvement. GDEs in parenthesis are the more ambiguously influenced elements that are only slightly distinguished by quantitative and qualitative data.

**Table 1.** Most influenced GDEs per stakeholder in each co-design stage.

<b>Co-design stage</b>	<b>Stakeholder</b>	<b>Game design elements</b>
Scoping / co-design	Clients	Technology, <i>pedagogy, mastery</i>
Co-design	Pedagogy experts	Pedagogy, <i>goals</i>
Co-design	Content experts	<i>Ambiguous</i>
Co-design / testing	Teachers	Pedagogy, mastery
Co-design / testing	Parents / guardians	<i>Ambiguous</i>
Testing	Children	Engagement, aesthetics, mechanics

Additionally, Figure 3 shows that from the 15 GDEs, those from Mackling & Sharp (Goals, Playspace, Actions, Rules, Player, Objects) were among the lowest ranking and least distinguished. They likely contributed to ambiguity in this research. For further studies or iterations of this work, it is recommended to include fewer elements for more precise results.

## 5 Conclusion

Co-design is being practiced by serious game companies that develop EVGs because of the benefits it offers. The involvement of stakeholders can improve games in terms of content quality, user engagement, and their impact on their intended audience. The degree to which stakeholders are involved varies among companies. As long as they are thoroughly sampled for input and feedback, the benefits of their involvement should persist. It is recommended for companies with fewer resources to systematize their co-design practices through custom applications and structured processes.

This study identified three stages of co-design and five types of stakeholders. It also revealed in which co-design stages each stakeholder is most commonly involved and how they influence GDEs in a diverse sample of EVGs. While their influence on most GDEs was inconclusive, indicators were found to support certain stakeholders consistently influencing specific GDEs. A larger research sample may have been able to provide more reliable data and less ambiguous results. However, stakeholders can be related to individual GDEs, thereby understanding how they influence specific aspects of the game. Further research of stakeholder-GDE relationships could lead to more efficient, reliable, and systematized methods to involve stakeholders in the co-design process. This research focused on EVGs for children of primary education, but it would be worth exploring how co-design could be optimized for other age ranges, specific cultural contexts, or the delivery of different content; STEM, history, language, and other fields.

Developing data-driven systems and methodologies for the co-design of EVGs could improve the design of these products. EVGs are used in many contexts, from cultural and healthcare to formal education. Having better and more impactful games as educational tools available could provide a meaningful contribution.

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### **References**

1. Papadakis, S.: The use of computer game in classroom environment. *International Journal of Teaching and Case Studies* 9 (1), 1 (2018). DOI: 10.1504/IJTCS.2018.10011113
2. Manesis, D.: Digital Games in Primary Education. In: *Game Design and Intelligent Interaction* 1<sup>st</sup> edn. IntechOpen, United Kingdom (2020). ISBN: 9781838800109.
3. Prahalad, C. K., Ramaswamy, V.: Co-Creation Experiences: The next practice in value creation. *Journal of Interactive Marketing* 18 (3), 5 (2004). DOI:10.1002/dir.20015
4. Sužnjević, M., Homen, M.: Use of Cloud Gaming in Education In: *Game Design and Intelligent Interaction* 1<sup>st</sup> edn. IntechOpen, United Kingdom (2020). ISBN: 9781838800109.
5. Macklin, C., Sharp, J.: *Games, Design and Play: A detailed approach to iterative game design*. 1<sup>st</sup> edn. Addison-Wesley Professional, United States (2016). ISBN: 9780134392073.
6. Kalmpourtzis, G.: *Educational Game Design Fundamentals: A journey to creating intrinsically motivating learning experiences*. CRC Press, United States (2019). ISBN: 9781138631540.