AIS Transactions on Human-Computer Interaction

Volume 15 | Issue 3 Article 4

9-2023

The Art of Serious Game Design: A Framework and Methodology

Naza Djafarova
Toronto Metropolitan University, ndjafaro@ryerson.ca

Anastasia Dimitriadou
Toronto Metropolitan University, adimitriadou@ryerson.ca

Leonora Zefi
Centennial College, lzefi@centennialcollege.ca

Ozgur Turetken
Toronto Metropolitan University, turetken@ryerson.ca

Recommended Citation

Djafarova, N., Dimitriadou, A., Zefi, L., & Turetken, O. (2023). The Art of Serious Game Design: A Framework and Methodology. *AIS Transactions on Human-Computer Interaction, 15*(3), 322-349. https://doi.org/10.17705/1thci.00193
DOI: 10.17705/1thci.00193

Transactions on Human-Computer Interaction

Volume 15 Issue 3

9-2023

The Art of Serious Game Design: A Framework and Methodology

Naza Djafarova

The Chang School, Toronto Metropolitan University, ndjafaro@ryerson.ca

Anastasia Dimitriadou

The Chang School, Toronto Metropolitan University, adimitriadou@ryerson.ca

Leonora Zefi

Centre for Faculty Development and Teaching Innovation, Centennial College, lzefi@centennialcollege.ca

Ozgur Turetken

Ted Rogers School of Management, Toronto Metropolitan University, turetken@ryerson.ca

Recommended Citation

Djafarova, N., Dimitriadou, A., Zefi, L., & Turetken, O. (2023). The art of serious game design: A framework and methodology. *AIS Transactions on Human-Computer Interaction*, *15*(3), pp. 322-349.

DOI: 10.17705/1thci.00193

Available at http://aisel.aisnet.org/thci/vol15/iss3/4

Transactions on Human-Computer Interaction

Research Paper DOI: 10.17705/1thci.00193 ISSN: 1944-3900

The Art of Serious Game Design: A Framework and Methodology

Naza Djafarova
The Chang School, Toronto Metropolitan University, ndjafaro@torontomu.ca

Anastasia Dimitriadou
The Chang School, Toronto Metropolitan University, adimitriadou@torontomu.ca

Leonora Zefi
Centre for Faculty Development and Teaching Innovation, Centennial College, lzefi@centennialcollege.ca

Ozgur Turetken
Ted Rogers School of Management, Toronto Metropolitan University, turetken@torontomu.ca

Abstract:

Serious games developed for learning have gained popularity due to their promise for better learning outcomes. However, designing these games can be costly, take a long time, and may not lead to the desired outcomes if an adequate design process is not followed. Especially critical in this process is the creation of an effective game concept. Based on our experience in serious game development and the research gap we identified from the relevant literature, we developed the Art of Serious Game Design (ASGD) framework and methodology to aid developers in the concept-development stage of the serious game design process to address the needs of multidisciplinary teams through a practical step-by-step methodology. The ASGD methodology offers good potential in helping multidisciplinary serious game design teams improve the design process and, ultimately, the outcomes of serious games. We evaluated ASGD through a mixed-method approach and found that multidisciplinary game design teams perceived its positive effects in efficiency, structure and flow, usability, and team support. The actual prototype design process reflected these perceptions as well. ASGD was applied in practice to lead the design of a serious game during concept development, which produced a structured and detailed game concept with well-integrated learning outcomes in a timely manner. We conclude that the ASGD framework and methodology constitute a valuable tool for multidisciplinary teams working on the development of a serious game concept because of its ability to enhance brainstorming (through iteration) and streamline communication between team members.

Keywords: Game-based Learning, Serious Games, Serious Game Design, Serious Game Concept Development, Design Methodology, Multidisciplinary Process, Design For Human-Computer Interaction, Process Improvement

Stacey Petter was the accepting senior editor for this paper.

1 Introduction

Since the late 2000s, serious games have exploded in popularity and have a strong presence in every culture (Djaouti et al., 2011; Treiblmaier et al., 2018). Unlike traditional games that people typically play for entertainment, serious games (SG) combine a challenge-based activity with entertainment and focus on problem-solving rather than pure entertainment (Pilote & Chiniara, 2019). Sources have projected that the SG market will grow to US$32.72 billion by 2030 (Gaikwad et al., 2022). Depending on the sector in which one uses them (e.g., education, health, business, armed forces, and aviation) (Brandão et al., 2016), SG promote a specific outcome such as behavior change, learning, or training. For example, the Food and Drug Administration (FDA) recently approved a prescription-only digital game for attention deficit hyperactivity disorder for therapeutic purposes (Food and Drug Administration, 2020). There is also a growing demand for SG as an educational tool (e.g., Arnab et al., 2015; Hamari et al., 2016; Iten & Petko, 2016; Vlachopoulos & Makri, 2017), which is the focus of this paper. Hence, our focus is on digital games and simulations that have learning objectives linked purposefully to game objectives and that teach players content or skills in an engaging and entertaining way.

Research has highlighted that SG may lead to better learning outcomes across educational levels (e.g. Clark et al., 2016; Sitzmann, 2011; Vogel et al., 2006; Wouters et al., 2013), and recent studies further show that SG increase students' engagement, positively affects their ability to learn various subjects, and leads to a significant increase in knowledge and skills development (e.g., Baboo et al., 2022; Petri et al., 2022; Beranič & Hericko, 2022; Calik & Kapucu 2022). Additionally, Mehta et al. (2022) found SG to increase educational performance when compared to discussions, while also promoting inclusiveness.

Incorporating SG into both classroom-based and online environments can enhance learning through divergent thinking and experiential learning (Anderson et al., 2009). SG may be particularly effective for stimulating cognitive functions at higher levels by facilitating the development of skills such as critical thinking, evaluation, and creativity (Anderson & Krathwohl, 2001), which are necessary skills for high-level academic and professional development.

Notwithstanding the potential benefits of SG, the design process for game-based learning brings along complex and multifaceted problems. The design process requires multidisciplinary expertise at different stages (Kirjavainen et al., 2007). SG design team members with very diverse backgrounds and expertise need to communicate effectively since their skills complement one another. For example, technically oriented developers need a pedagogical perspective, whereas subject matter experts (SME) need help in making the game entertaining for their intended audiences (Arnab et al., 2015; Gunter et al., 2006). Team members may also be accustomed to different methodologies and approaches to working (Hirumi & Stapleton, 2008; Korhonen et al., 2017; Musil et al., 2010), which may present a challenge in establishing a clear shared vision.

SG design processes require an environment that encourages creativity, expressiveness, and flexibility since one cannot impose a strict structure on these processes. Game design processes tend to deploy different approaches, such as agile or waterfall workflows, depending on the size of the design and development team and the purpose of the game (e.g., for entertainment, education, or therapeutic purposes). These processes may loosely follow an ad hoc methodology or framework. For SG, the process generally comprises different stages divided into pre-production, production, and post-production. Pre-production refers to all preparatory steps necessary for production, such as concept development; production refers to efforts to actually develop a SG; and post-production includes testing, evaluation, and adoption.

As project members involved in designing SG, we have experienced issues related to miscommunication between team members and needed to better understand roles and expected outcomes related, in particular, to ideating games (i.e., concept development). Based on our experience in SG design, we have found that the initial stage, where all the game characteristics are decided upon to support learning objectives, is very critical, and requires guidance and streamlining, especially when a multidisciplinary team is involved. However, the way in which different game characteristics of a SG are linked together before a SG is produced remains under-investigated (Bellotti et al., 2010; Ke, 2016). To fill that gap, we emphasize the concept-development stage, as Hirumi and Stapleton (2008) described in their SG design and development process, to reduce the need for redesign or rework at the later pre-production (involving game design creation, production planning, and prototyping) and/or production (where the concept is formed into a product) (Hirumi & Stapleton, 2008) stages. We found that our framework and methodology helped the

development teams in the concept-development stage as they allowed our team to overcome communication issues and prevented overlapping roles.

The concept-development stage deserves special attention because, in this stage, design teams have to resolve rising challenges that, if left unresolved, will remain throughout the entire design process. In this stage, teams also make fundamental decisions about the learning objectives, plots, characters, and/or the setting of the game. When conceptualizing a game idea, designers seek inspiration from different sources by using different methods from their personal experiences; hence, a systematic approach could help them integrate the different methods when conceptualizing a serious game (Kultima, 2010).

Even though researchers have acknowledged the need for a unified methodology (Aslan & Balci, 2015) and the various design frameworks that already exist (e.g. Arnab et al., 2015; Groff et al., 2015; Winn, 2009), such as game-ideation models (e.g., Athavale & Mohan, 2018; Hagen, 2009; Tschang & Szczypula, 2006), multidisciplinary teams lack practical methodologies that they can use as guidance during the initial phases (i.e., concept development) of SG design. (Kultima, 2010). We propose the Art of Serious Game Design (ASGD) framework and methodology as a SG concept development guide to address these challenges. The ASGD has been evaluated through a set of studies and real-life applications that attest to its potential to improve the design process and outcomes of serious games.

This paper proceeds as follows: in Section 2, we review the literature on existing SG design frameworks. In Section 3, we introduce our research approach and discuss how we developed and evaluated the ASGD framework and methodology. In Section 4, we discuss the implications of our findings for SG design and development practice as well as the contributions of our study to academia. We also discuss the limitations of our work and future research directions. In Section 5, we conclude the paper.

2 Literature Review: Serious Game Design Frameworks

There are no agreed-upon definitions for terminologies used in game design, and various research and practice efforts attach different, sometimes conflicting, meaning to the same concepts (Lo et al., 2021). For this reason, in this paper, we define game components as the building blocks of a SG, and SG characteristics as the attributes inherent in game components. In this section, we synthesize the literature on the guiding principles for developing SG into theoretical models and frameworks. To do so, we define a theoretical model as an abstraction of how game components may link together and a framework as an approach for how to use game components in the process for designing SG. SG design models tend to provide abstract guidance rooted in theoretical considerations, while SG frameworks tend to provide more practical guidance resembling a design process. Both models and frameworks may focus on specific stages or the whole design process. Those that focus on specific stages tend to be more detailed and prescriptive. Several established theoretical models and frameworks describe how serious games promote learning (e.g., Amory, 2007; Annetta, 2010; Arnab et al., 2015; de Freitas & Oliver, 2006; Dickey, 2005; Djaouti et al., 2011; Habgood et al., 2005; Ke, 2016; Landers & Callan, 2011; Wilson et al., 2009). Yet, to date, we lack any widely promoted, operational models or frameworks that provide multidisciplinary teams with a practical methodology that addresses and evaluates the concept-development stage in the SG development process. In reviewing the literature, we examined existing models and frameworks for the concept-development stage to identify:

1) Evidence of grounding in design and pedagogical theory,
2) A design process that aided pre-production concept-development stage, and
3) An operational methodology that linked learning objectives to other game characteristics and allocated roles to specific design team members.

We found that many studies used the terms SG models and frameworks interchangeably, which would make it difficult for design teams to identify processes and elicit methodologies. Specifically, SG models (see Appendix A), which we identified based on the definition we provide above, varied in the game components they identified and the way these components were mapped to game objectives. Their value comes from their basis in design and pedagogical theory as well as their abstract depiction of SG components and how they link to each other, with varying emphasis. For instance, the triadic theoretical framework (Rooney, 2012) emphasizes the need for balance, the balanced design framework (Groff et al., 2015) focuses on assessment, while the learning mechanics and game mechanics mapping framework (Arnab et al., 2015) links learning with game objectives. Except for a design process approach that helps teams develop their own methodologies by addressing how SG components link to each other, no model provides a

methodology that comprises step-by-step guidance about how to interconnect learning objectives with game characteristics in the concept-development stage. Furthermore, no model provides any guidance for SG design team composition, roles, and task allocation. Thus, we need a framework with concrete guidance for multidisciplinary SG design teams.

Furthermore, existing models only vaguely address multidiscipline as a concept. While researchers have acknowledged the complex nature of multidisciplinary design teams (Rooney, 2012), existing models do not emphasize multidisciplinarity as applied in practice. For example, the four-dimensional framework (de Freitas & Oliver, 2006) and exploratory learning game design model (de Freitas & Neumann, 2009) limit opportunities for intra-team communication and activities, and the learning games design model places a strong dependence on the consensus between team members' theoretical approach to learning (Chamberlin et al., 2012). In practice, such dependence on consensus may lead SG design teams to freely interpret these models and apply them to other software development processes, which may or may not work for a SG product. Additionally, team members may lack clarity about which role to include and/or adopt in the design process, how to start designing a SG, and how to assess whether an initial product meets the envisioned learning and game objectives. Hence, existing models treat a very practical task that requires more specific operational guidance at an overly abstract level.

For this reason, we identified characteristics that multidisciplinary teams participating in the concept-development stage of a serious educational game could use. Next, we briefly review the major SG frameworks that focus on the successful linking of pedagogy and entertainment (Table 1).

Table 1. Major SG Design Frameworks Related to the Concept-development Stage

Theory/authors	Framework key characteristics/features	Key shortcomings
Games Eules scEnario Model (GREM) (Zarraonandia et al., 2015)	● A conceptual game model that 1) organizes game features that can produce an engaging serious game experience and 2) helps developers reuse serious game design characteristics. ● GREM contains two submodels: the game rules model, which describes a game's norms and rules, and the game scenarios model, which defines a game's virtual environment and user interface. ● Zarraonandia et al. (2015) tested the GREM for ease of use and applicability in a game design workshop and reported that GREM supports the completion of a game model during the allotted timeframe.	● Repurposing characteristics may cause a team 1) to shift a game's focus from effective learning as the model does not contain learning objectives at its core, and 2) to focus on reusing game features rather than designing new ones and, hence, restricting innovation in game design. ● Does not provide empirical data around usability.
Activity Theory-based Model for Serious Games (ATMSG) (Carvalho et al., 2015)	● The ATMSG examines the connection between a serious game's educational and entertainment factors at different levels of detail. ● The model approaches a SG as a tool for three activity systems: the gaming activity, the learning activity, and the instructional activity. ● The model provides a SG component taxonomy (gaming, learning, and instructional) and a framework as tools for analyzing SG. Developers can use the same process with a SG prototype once they have identified its activity systems' goals and characteristics.	● Its creators designed the ATMSG for analyzing rather than designing SG. ● The model presupposes existing game goals and game characteristics when used to evaluate a new SG prototype. ● Evaluation for perceived usability and usefulness suggests that the ATMSG process is complex and requires simplification.

Table 1. Major SG Design Frameworks Related to the Concept-development Stage

Design, Play, and Experience (DPE) (Winn, 2009)	• The DPE has five main components: learning, storytelling, gameplay, user experience, and technology. In turn, it links these components (except technology) to the design, play, and experience layers. • DPE acknowledges the interaction between the design input and player experience. • While researchers designed DPE as a game-evaluation tool, one can also use it as a SG design process. • The DPE's design process involves defining a game's goals and developing a suitable design, creating and testing a prototype through playtesting, and iterating back to the design to modify it according to the playtest results.	• Its creator designed DPE for analyzing rather than designing SG. • The technology component may restrict creativity when one uses DPE for SG design. • DPE's linear thinking approach may restrict creative brainstorming. • No empirical data regarding its effectiveness exists.

The GREM's strong focus on reusing game characteristics makes it difficult for a design team to control the interconnection between learning and game objectives, which may lead to a serious game that does not meet its learning purpose. ATMSG requires design teams to have a thorough knowledge of Vygotsky's approach to activity theory (Carvalho et al., 2015), which has its basis in applied psychology—not a subject that game designers would necessarily be familiar with. The DPE is the simplest framework, uses clear language to help multidisciplinary design teams communicate, and balances design team roles. However, it follows a linear process as Winn (2009) developed it to analyze, not develop, SG. Linear thinking in SG design may divert focus from fully or partially interconnecting all game characteristics and can limit the exchange of ideas and creativity in a SG design and development team, which, in turn, may result in oversights and shortcomings in design.

Silva (2019) recommends a practical methodology for developing SG inspired by the DPE framework that depicts the main steps in the design process as two flowcharts. Despite the methodology's linearity, Silva argues that it is more holistic than the DPE framework because "it identifies all the main steps that are needed to define the learning mechanisms in an educational serious game" (p. 1). However, as the author notes, the process does not work well with simulation games as "this kind of game has its own rules according to the system that it wants to mimic" (p. 9). Additionally, although the methodology has a starting point, it lacks guidance about how to start. For example, the methodology does not provide guiding questions or ideas for brainstorming to teams, or distinguish between the different roles of multidisciplinary team members.

Each of the above frameworks provides a unique perspective to game design and can be used as a tool during the design process; however, each of them does not, by itself, provide sufficient practical guidance for a multidisciplinary team. Further, the game design frameworks reviewed above, although divided into sequential stages or phases (Kuittinen & Holopainen, 2009), lack an initiation point (i.e., concept development). Note that, in general, SG design largely adopts a backward design approach (Wiggins & McTighe, 2005) where learning content and other game characteristics are derived from the game's learning outcomes. Designers need a practical SG methodology for the concept-development stage that is strongly linked with the learning outcomes for designing and developing engaging digital learning games. Hence, existing SG design frameworks may have limited value to multidisciplinary SG design teams.

Designing effective SG requires a different approach with a basis in pedagogical design to ensure a good balance between entertainment, engagement, and learning. Design teams that do not synthesize learning with other game characteristics may lead to an engaging but unsuccessful learning activity, while a strong focus on learning without entertainment may lead to a boring game. Focusing on developing concepts via using a guiding methodology can help a design team develop a SG that entertains its users but also helps them learn.

To summarize, given the deficiencies in existing frameworks and processes, we designed an operational and practical methodology that addresses what multidisciplinary teams require (namely, common understanding across disciplines and the ability to combine creativity and expressiveness with technical knowledge) in the concept-development SG design stage.

3 Research Approach

In this study, we focus on developing and validating a design methodology—the ASGD—based on a mixed-methods approach. We adopted such an approach since it allows researchers to collect data through both qualitative and quantitative methods and, therefore, expand and strengthen a study's conclusions (Schoonenboom & Johnson, 2017). In particular, a mixed-methods approach can expand and strengthen a study's conclusions through concurrent triangulation whereby one integrates data in the analysis stage to identify whether findings from different sources support or contradict one another and, hence, determine the reliability of the findings (Hanson et al, 2005; Morell & Tan, 2009). To collect data for the ASGD methodology, we conducted participatory workshops, observed participants, analyzed prototypes, and administered a survey after the workshops.

Participatory workshops provide an effective means to evaluate a new design methodology because they allow participants to fully engage with its procedures and artifacts while producing a desired outcome. Additionally, they allow one to observe how participants engage with a given methodology. Hence, our observers acted as ethnographer observers (Ørngreen & Levinsen, 2017) during the workshops. Furthermore, with participant observation, we could rigorously evaluate the ASGD methodology's artifacts and their relevance to SG concept-development practices (Sonnenberg & Brocke, 2011).

The analysis of prototypes as ASGD artifacts was another source of data, as they allow for the extraction of 'static knowledge from the artifact', promoting knowledge exchange between research and practice (Müller and Thoring, 2011, p.1) (Müller & Thoring, 2011, p.1). Prototyping involves sketching a game idea and constitutes an important tool in game design (Tekinbas & Zimmerman, 2003; Schell, 2008). The observers focused their attention on how group members engaged with the ASGD methodology and its artifacts, how they interacted with one another, and how they produced prototypes as design artifacts.

Lastly, since questionnaires can help one identify varying perceptions between different user roles in participatory workshops (Thoring et al., 2020), we collected participants' feedback on the ASGD methodology through a feedback questionnaire.

3.1 Process for Framework Development

Given the deficiencies in existing frameworks and methodologies, we sought a methodology with interdisciplinary potential. Due to the simplicity in its terminology and its interdisciplinary focus, we adopted the DPE framework as a foundation for developing the ASGD framework and methodology (refer to Figure 1 below). We chose the DPE framework over other existing frameworks that we reviewed because it acknowledges the interaction between the design input and player experience and because it possesses structural clarity and uses simple language for instruction (Winn, 2009). Based on a pilot study where we evaluated the DPE framework, we obtained insights into how users perceive it in practice and how we could refine it to increase brainstorming, to foster members to exchange ideas, and to improve the flow of the design process. Such user feedback played an essential role in our efforts to develop the ASGD framework and methodology.

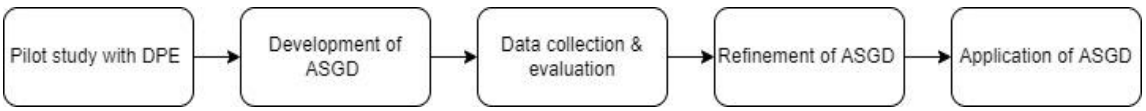

Figure 1. The Research Process

3.2 Pilot Study with DPE

Based on reviewing the major SG design frameworks (see Table 1), we identified DPE as the most promising framework as a starting point for developing the ASGD and conducted a pilot participatory workshop in order to evaluate the DPE framework (Winn, 2009). We made minor adaptations to the questions from Winn's (2009) construction sheets. Eight participants whose backgrounds ranged from SG design and development practitioners, subject matter experts, instructional designers, game designers, and software developers attended the pilot workshop. We divided the participants into two teams. During the workshop, we introduced them to the DPE framework by asking them to analyze a well-designed, popular digital game using the DPE construction sheets. Both teams then engaged in brainstorming to conceptualize

a serious game in academic integrity following the DPE process. During brainstorming, teams held constructive debates and generated ideas, which led them to design a low-fidelity prototype (LFP)—a paper-based sketch that depicts their game idea. Only one group successfully completed an LFP in the given timeframe, but the completed LFP did not provide the expected details about the game. We also observed that including the application developers early in the design process impeded creativity and idea generation as they raised technical constraints prematurely.

From the pilot workshop, we identified the DPE framework as a helpful tool for multidisciplinary SG design teams because it initiated and kept interaction in teams alive and flowing. Teams could easily deconstruct a digital game's characteristics. However, the DPE forced linear thinking that impacted brainstorming. Although it has appropriate, coherent, and interrelated sections, it has a rigid structure (participants had to answer questions in a strict sequence), which impacted how much brainstorming participants could perform and its quality, which limited their team's creativity and iterations. Based on these observations, we designed the ASGD framework and design methodology based on the DPE framework. Specifically, we added supporting artifacts that allow for richer brainstorming and iteration during the concept development of SG.

3.3 Development of the ASGD Methodology

The ASGD framework and methodology use characteristics from the DPE framework, which builds on the underlying notion that a game tells the designer's story and the player experiences differently depending on the decisions that the player makes during the game. As Figure 2 shows, we depict the ASGD framework as a circle with three circular layers, one inside the other: a) the inner design layer symbolizes the designer's input, which refers to all characteristics that the designer introduces into the game; 2) the play layer symbolizes the interaction between the player and design input through play; and 3) the large outer experience layer symbolizes the varying play experiences players can have depending on the choices and actions that they make during the game.

The ASGD framework depicts the learning, storytelling, gameplay, and user experience game components as four equal circle quadrants to emphasize their equally important role in the design process and the need for iteration between the layers and the game components.

Learning refers to the content that the game will teach and that will help users achieve specific and measurable learning outcomes. **Storytelling** refers to the game's background story and describes its character(s), setting, and target, or destination. The ASGD framework distinguishes between embedded narrative (the intended story that the design team provides), and emergent narrative (the narrative form that depends on choices that the player makes during play and will slightly differ each time).

Gameplay refers to the way in which the player interacts with the game, or with others, in the case of a multiplayer game. This interaction is largely determined by the game's goal and rules, or game mechanics, and the dynamics, which refer to a player's behavior as influenced and represented by a game's rules over time. Gameplay encapsulates the type of game activity (e.g. shooter, puzzle, trivia, etc.). Game mechanics refer to the rules or methods devised by a team to determine player and game interaction, engage the player, and allow the player to achieve a game's goal.

User experience refers to the space where a human and a computer interact. It contains the sensory input such as visuals and audio but also determines the game controls. Control-mapped actions refer to the predetermined action options that a player can choose from when using game controls. User experience design creates a play environment that emphasizes a player's emotions and attitudes arising during gameplay and the way the player communicates with the game.

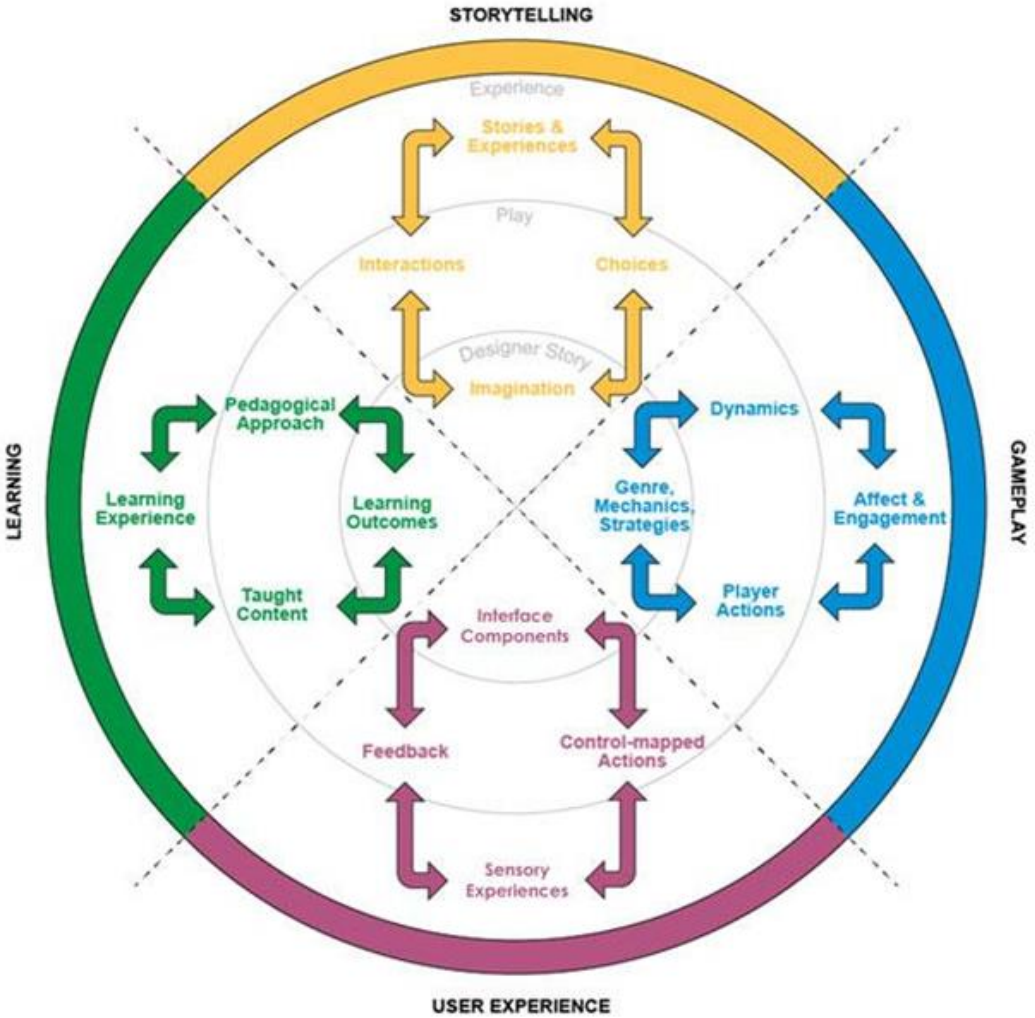

Figure 2. The Art of Serious Game Design Framework

The ASGD methodology differs from the DPE in several ways. First, we developed two additional tools: ideation cards and a glossary of terms. Ideation cards include questions on each DPE component: namely learning (e.g., what are the game's learning objectives?), storytelling (e.g., what is the setting of the game?), user experience (e.g., how are the players experiencing the story and how does the game present progress/scores?) and gameplay (e.g., what actions can the player take?). Second, we simplified the language of the brainstorming questions and developed a glossary of terms. The glossary outlines definitions that the team could refer to during brainstorming and helps to ensure consistency and clarity in terminology. Third, we provided SG design teams with a step-by-step methodology that differentiates team roles in the process. Finally, in the methodology, we delayed the application designers' and developers' participation from the first iteration of the initial brainstorming because we designed it purposely to not focus solely on technology in the initial brainstorming in order to encourage more creativity in the brainstorming process (Godoy & Barbosa, 2010; Moser et al., 2014). Therefore, only subject matter experts and instructional designers conduct the first iteration of the initial brainstorming activities before they present a game idea to the larger design team. The methodology addresses technological considerations in the post-brainstorming stage when designing the low-fidelity prototype (LFP) (see Table 2).

We designed the ASGD to also allow teams to answer questions about game design components in any sequence for more fluidity and creativity. We added an iteration later by asking the key questions more than once to enable teams to refine ideas (refer to Figure 2). While the DPE framework addresses each game

component at a time, ASGD places emphasis on the balanced/equal interaction between the game components in each quadrant.

3.3.1 ASGD Methodology for Game Concept Development

Based on the framework that we describe above, we operationalized a design methodology that uses several design artifacts (namely, a set of ideation cards, a glossary, and an ASGD framework poster) to help teams visualize the game characteristics and naturally select and move ideas across all game components during brainstorming iterations (refer to Appendix B for ASGD artifacts). Ultimately, this stage focuses on developing a detailed low-fidelity prototype (LFP). It mediates designers' activities, increases collaboration and dialogue, represents their ideas, and helps them simultaneously develop the design problem and its solution (Manker & Arvola, 2011).

The ASGD comprises three stages (see Table 2). We created a short two-minute video to illustrate the concept-development stages and the workshop activities (see https://tinyurl.com/283xa6xw).

Table 2. Concept-development Stages

Stage	Activities	Tools/actions	Roles/ participants
1) Brainstorming (part 1) (45-60 minutes)	Generate preliminary many design ideas across all game components assess needs and identify goal(s) analyze goal(s), learner, and context	Use 20 (ideation) cards with solid borders. Team members can choose cards randomly but ideally should not draw more than two cards from the same category in a row. Add sticky notes to the inner circle.	Instructional designer (ID), subject matter experts (SME) (2-4 people)
2) Brainstorming (part 2) (2 hours)	Further develop initial design ideas add and refine game details across all game characteristics Check that game details align with learning objectives	Use 20 (ideation) cards with striped borders. Team members can choose cards randomly, and ideally should not draw more than two cards from the same category in a row. Add sticky notes to the inner circle.	ID, SME, designers, developers (6-8 people)
3) Prototyping (1 hour)	Design a detailed LFP	ASGD framework poster	ID, SME, designers, developers (6-8 people)
4) Post-brainstorming	Technology and accessibility considerations Revise brainstorming	LFP, brainstorming notes	ID, SME, designers, developers (6-8 people)

After the fourth stage, an SG project enters production, where, depending on the game type, the team creates the game's graphics and storyline. If the team needs to film, they develop a script first. After edits and revisions on the graphics, storyline, and/or script (filming takes place after the team has finalized the script), the game content enters the development phase. At that stage, an SG design team can follow an existing SG model or framework or their own in-house process depending on what type of game they want to develop (e.g., real-life simulation, video game, etc.), their resources and time, and their familiarity with a given model or framework.

3.4 Data Collection and Evaluation

For evaluation purposes, we prepared a questionnaire with 19 items that measured how users perceived the ASGD methodology's value on a five-point Likert scale that ranged from strongly disagree (-2) to strongly agree (2). The evaluation focused on the following criteria: structure and flow, usability, team communication, applicability, and efficiency. We established these evaluation criteria when we reviewed the DPE to determine its suitability to support our study's objectives.

We conducted two participatory design workshops that each lasted half a day with 18 participants. The participants comprised professionals involved in SG design and development, such as subject matter experts, instructional designers, game designers, and developers. We divided them into three groups and asked them to follow the ASGD methodology to design an SG on bicycle safety. We intentionally divided participants into groups to include a mix of roles (instructional designers, faculty/subject matter experts in

the first stage, instructional designers, faculty, designers, and developers in all other brainstorming stages) simulating real SG design team composition. After the participants signed consent forms, workshop facilitators briefed them about the ASGD framework and methodology and provided them with a package of color-coded handouts but instructed them not to look at them. The package included an SG design glossary, a chart with action verbs and activities based on Bloom's taxonomy of learning (Hokkanen, 2015), a list of questions on technology issues in SG design that they could discuss after the brainstorming process, and a workshop evaluation questionnaire. Then, the facilitators presented to the teams the brainstorming cards, the ASGD framework poster, and sticky notes for idea recording and asked them to consult the ASGD instructions, the glossary, and the chart from their package. The facilitators provided guidance to teams when needed.

Only subject matter experts and instructional designers participated in the initial brainstorming; we excluded developers to allow the former to be as creative as possible without technological limitations influencing them. Subsequently, developers joined the group and the brainstorming and idea refinement continued. Facilitators asked both teams to design an LFP on the topic of academic integrity using the DPE construction sheets. Lastly, participants completed a questionnaire for feedback.

We evaluated the ASGD methodology through participant observation, a feedback questionnaire at the end of the workshop, and prototype analysis. We assigned one observer to each team, and they did not participate in brainstorming to maintain research integrity. During observations, the observers maintained objectivity by following observation instructions and thematic focus, and we minimized bias via establishing clearly defined roles, rules, and workshop procedures. We analyzed observation notes following a thematic analysis.

With the feedback questionnaire, we focused on identifying impressions and perceptions about the ASGD's value. We linked its items directly with measuring satisfaction for the criteria on which we created the ASGD framework and methodology (see Table 3). We analyzed quantitative data with the non-parametric one-sample Wilcoxon Signed rank test (with IBM SPSS version 26) as this method better fits studies with small sample sizes (Dwivedi et al., 2017).

As a final form of evaluation, we assessed the LFP design by focusing on game rationale, gameplay details, and functionality. Specifically, we focused on evaluating the alignment between the learning objectives and game objectives, and how game details linked to these objectives and created an engaging environment. The storyline, game mechanics, characters, environment, objects, and their detailed description indicated quality brainstorming. By qualitatively evaluating the LFPs in this manner, we could assess participant perceptions about, and their engagement with, ASGD during workshops in a balanced way. In other words, we could triangulate qualitative and quantitative evidence and enhance the ASGD evaluation.

3.4.1 Results

The workshop evaluation indicated that, in general, the ASGD methodology effectively guided multidisciplinary teams through the concept-development stage. Qualitative effectiveness indicators included the fact that all participating multidisciplinary teams could smoothly apply the methodology, which meant they could successfully complete detailed LFPs by the end of the workshop. We found the methodology effective in guiding teams through creative brainstorming and encouraging effective communication: participants debated ideas and commonly agreed on decisions.

We display the descriptive statistics from the survey responses in Table 3. As one can see, responses to most items in the survey had a positive skew, which indicates that participants tended to agree with the items presented. Team communication emerged as the category with the most homogenous responses, which indicates strong agreement. This finding concurs with qualitative data, which further confirmed that the process promoted and enhanced team communication. In contrast, items that showed mixed responses in participants' attitudes concentrated on applicability: specifically, in the questions "I will use this process in my future game design" and "I don't think this process helps me overcome problems I face when designing serious games.", the interquartile range was 3 on a five-point scale. These variables showed the greatest variability.

Table 3. Descriptive Statistics for Survey items

Category	Item	Median	IQR
Structure and flow	1a) I think that the steps in this process follow a logical sequence.	4	1
	1b) I think that the process covers the most appropriate areas of game design.	4	1
	1c) I think that the use of brainstorming cards is appropriate.	4	1
Usability	2a) I think the process is clear to follow and apply.	4	1
	2b) I think that the process can be useful for game design teams.	4	2
	2c) I think that this process can be simplified.	4	2
	2d) I feel confident applying this process in my next game design project.	4	1
	2e) I think that the language used in the brainstorming cards is clear.	4	1
Team communication	3a) I think that the process allows all team members the opportunity to provide their input.	4.5	1
	3b) I think that the brainstorming cards effectively help to generate ideas.	4	1
	3c) After using this process, I think that I have a better understanding of the various components of game design.	5	1
	3d) I see the value in using this process in a multi-disciplinary game design team.	4.5	1
	3e) I think that the process helps to identify each team member's role in game design.	4	2
Applicability	4a) I think this process addresses some of the challenges we face when designing serious games.	4	2
	4b) I don't think this process helps me overcome problems I face when designing serious games.	2	3
	4c) I think that this process is useful for my work in game design.	3.5	2
	4d) I will use this process in my future game design.	3.5	3
Efficiency	5a) I think following this process will improve the efficiency of game design.	4	2
	5b) I think following this process will help the team to better define the goal and scope of game design.	4	2

The identified areas for improvement included the communication mode for instructions. We observed a brief disagreement between the core design team and the developer team in one group and confusion about the methodology's structure between two team members in another group.

The results in Table 4 suggest that the ASGD methodology effectively guided multidisciplinary teams through the concept-development stage as most responses significantly differed from neutral in the direction that indicates a positive attitude (highlighted) toward using ASGD.

Table 4. Non-parametric One-sample Wilcoxon Signed Rank Test Results

Null hypothesis	P value
The median of item 1a is neutral	0.112
The median of item 1b is neutral	**0.001**
The median of item 1c is neutral	**0.002**
The median of item 2a is neutral	**0.008**
The median of item 2b is neutral	**0.003**
The median of item 2c is neutral	0.241
The median of item 2d is neutral	0.229
The median of item 2e is neutral	**0.005**
The median of item 3a is neutral	**0.000**
The median of item 3b is neutral	**0.000**

Table 4. Non-parametric One-sample Wilcoxon Signed Rank Test Results

The median of item 3c is neutral	**0.003**
The median of item 3d is neutral	**0.000**
The median of item 3e is neutral	0.113
The median of item 4a is neutral	**0.002**
The median of item 4b is neutral	0.100
The median of item 4c is neutral	0.091
The median of item 4d is neutral	0.370
The median of item 5a is neutral	**0.005**
The median of item 5b is neutral	**0.003**

Structure and flow: Most participants found that the ASGD methodology followed a logical sequence (the item median exceeded neutral but did not reach significance ($p = 0.112$)), found that it covered areas appropriately (the item median significantly exceeded neutral ($p < 0.01$)), and found the brainstorming cards appropriate (the item median significantly exceeded neutral ($p < 0.01$)). Qualitative responses also indicated a general satisfaction and identified using the cards as an appropriate tool for brainstorming "but not necessarily the only tool". One participant believed that the methodology "forces a more critical discussion on what might impact the end goals", while many found the glossary "critical" or "imperative". Regarding comprehension, most participants found the glossary as crucial in ensuring common understanding among all team members. It helped to ensure that all team members understood the terminology in the same way.

We observed that, at the beginning of the process, teams felt reluctant to read the instructions in their package; instead, they wanted to use the cards and expected verbal instructions from the facilitator. Once prompted to consult instructions, all teams successfully allocated roles to team members and used the cards without any major problems. Except for two team members from one team, most participants gave the impression that they followed the brainstorming process in sequence with ease while using the questions to stimulate their brainstorming through debating and reaching a common agreement before moving on to the next question. The provided feedback suggested that, although "steps in this process indicate[d] a specific order to follow, it was unclear as to which step should be the first step, and the logical flow to follow for the remaining three steps" and "important aspects such as time and money are not included in the tool".

Usability: Despite the confusion when teams began the concept-design process due to hesitation to go through instructions, we observed that all teams found applying the ASGD straightforward once they started. The questions guided the discussions between team members. They directed the team members through the process while encouraging iterations and focused discussions on particular game design considerations so that learning outcomes matched game characteristics.

Participants made mostly positive responses about usability. Specifically, the vast majority agreed that they found the ASGD methodology clear to follow (the item median significantly exceeded neutral ($p < 0.01$)), and useful for teams (the item median significantly exceeded neutral ($p < 0.01$)), while more than half agreed that they might apply the ASGD methodology in their next project (the item median did not significantly exceed neutral ($p = 0.241$)). Over half agreed that they found the language on the cards clear (the item median did not significantly exceed neutral ($p = 0.229$)). However, two-thirds also believed that the process could be simplified (the item median significantly exceeded neutral ($p < 0.01$)).

Constructive feedback about how to improve usability indicated that, while the glossary played an essential role in helping team members understand keywords in the questions and in avoiding "multiple interpretations", clearer language could further improve the process. In addition, one participant expressed that the process also helped bridge the instructional design and game design disciplines.

Team communication: We found the ASGD to facilitate and guide effective team communication. In every team, members engaged in in-depth discussions about issues encountered on the cards about their game. Also, all teams engaged in creative brainstorming and produced detailed LFPs at the end of the workshop. Furthermore, the ASGD framework and methodology helped multidisciplinary teams overcome communication barriers stemming from diverse experiences in game design and provided teams with a common language framework and guidance to brainstorm for SG.

Participants expressed a positive attitude toward team communication that the ASGD methodology facilitated. Specifically, they strongly agreed that the methodology allowed for equal input from team members (the item median significantly exceeded neutral ($p < 0.01$)), that it aided idea generation (the item median significantly exceeded neutral ($p < 0.01$)), and that it allowed members to better understand game composition (the item median significantly exceeded neutral ($p < 0.01$)). We also found evidence for this satisfaction in the constructive feedback that participants provided. For instance, one participant reported: "we practiced good team communication, clarifying, challenging, reinforcing or supporting" and that the process "provided the opportunity for collaboration". Interestingly, although the vast majority agreed that the ASGD methodology provides value for multidisciplinary teams (the item median significantly exceeded neutral ($p<0.01$)), one participant highlighted that "multidisciplinarity is really important [for] different perspectives, and generates ideas, [but] the cards are sometimes too complex". Thus, we can conclude that a balance needs to be struck between the extent to which the cards function as aids for multidisciplinarity and for generating creative ideas. Lastly, two-thirds of the respondents believed that the process helped them identify team member roles (the item median did not significantly exceed neutral ($p = 0.113$)), although some participants found the role identification unclear and suggested alternative models for team composition. For instance, one participant said: "There were only two roles (writing and reading) plus later the designer. Maybe there should be a moderator".

Applicability: The evaluation indicated slightly dichotomous perceptions among participants with respect to the applicability of the methodology. Particularly, while participants strongly agreed with the statement that the process addressed some challenges faced when designing SG (the item median significantly exceeded neutral ($p < 0.01$)), and disagreed with the statement that the process did not help overcome problems (the item median was not significantly lower than neutral ($p = 0.1$)), when asked about the process's usefulness for their work, the proportion of participants who agreed with the statement dropped to less than half (the item median did not significantly exceed neutral ($p = 0.091$)). Similarly, only half of the participants agreed when asked if they would use the methodology for their future work (the item median did not significantly exceed neutral ($p = 0.370$)).

These mixed responses may have resulted from most participants' unfamiliarity with using SG as a teaching tool. Indeed, only approximately one-third had advanced experience while over two-thirds had minimal or no prior experience with designing SG. In exploring the constructive feedback that participants provided, we found that many participants indeed had an interest in using the methodology but, for example, "I would like to try the process, but simplified. I haven't done serious game design; [it] gave me insight" or "I could apply this process, but it depends on the team", which refers to possible limitations they encountered in their teams.

During the workshops, we observed a disconnect between the core team members and designers/developers in one team when they began the second brainstorming stage. The core team overcame this disconnect by providing detailed information about their prior brainstorming in the first stage. This short disconnect may have resulted from the core team not brainstorming all the cards and, thus, not being able to provide detailed information about their game ideas to the designers/developers, which created a brief communication chasm. Also, while all teams effectively brainstormed ideas via good team communication and engagement in iterations with guidance from the cards, one group could not keep good timing and brainstormed only about half of the cards. Nevertheless, the group produced a detailed LFP like the other groups.

Efficiency: With respect to efficiency, the data from the workshop indicate that the cards increased efficiency because they aided multidisciplinary team members in making critical decisions at critical phases of the SG design process, such as decisions on how to incorporate learning in the game plot—a process that teams often found to be a very fluid concept development stage. In addition, the cards helped the teams define their goals and scope. Evaluation data supports this finding to some extent. The majority of participants agreed that the process increased efficiency (the item median significantly exceeded neutral ($p < 0.01$)) and that the process helped define goals (the item median significantly exceeded neutral ($p < 0.01$)). Constructive feedback that one participant provided indicated that "the process reinforces the need to re-examine goals and objectives of the game". Comments from the participants reflected the diversity in their experience level, such as "a simplified model would be very beneficial for [a] novice" and that "[the process] needs to be fine-tuned more. A bit too complex at first. Concept map [is] a little too busy. Helpful to focus on 'big picture' questions first".

Low-fidelity prototypes (LFP): All prototypes that the teams created depicted their brainstormed game in detail. Two teams designed their respective prototype on a poster that presented the player's perspective, the introductory screen with painted game controls, and graphic detail. The third showed the brainstormed game in a few screenshots. Evidently, all teams successfully displayed their game's detailed functions on their LFP, which indicates that they considered issues that the card questions prompted. The teams designed all LFPs for specific target audiences, identified the main character and secondary characters, and identified objects the main character interacted with. Similarly, all teams established game mechanics, which they linked to learning outcomes, and intertwined the mechanics and outcomes with a narrative that they graphically embedded in their LFPs. Although teams summarized only a fraction of their ideas into LFPs and despite the need for iteration, the teams produced fairly detailed LFPs (see Figure 3) in the workshops' duration.

The design teams that used the ASGD performed visibly better than the design teams that used the DPE as we discuss in Section 3. We could see as much in the richness of visual representations/cues, flow and sequence of ideas, the elaborate components included in the design, consistent terminology used for game components, and team efficiency (design completion time).

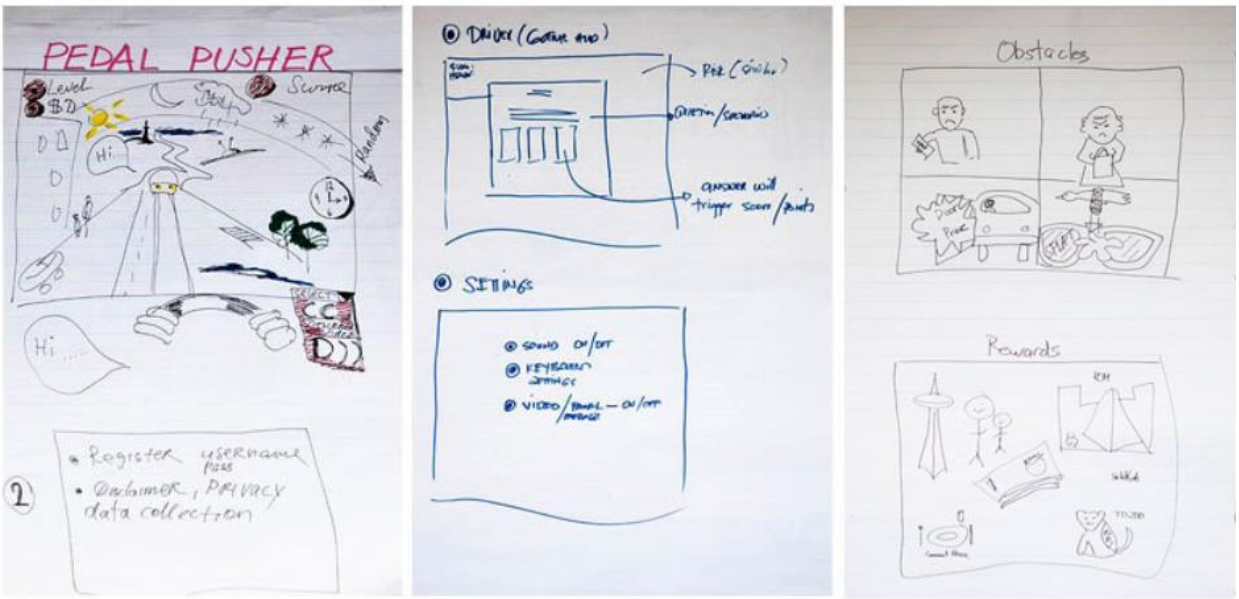

Figure 3. Extracts of Low-fidelity Prototypes Produced during Workshops

3.5 Refining the ASGD Methodology

After reviewing the workshop findings and considering participants' feedback, we made some revisions to the ASGD methodology and materials. For instance, we further clarified the language in the cards and glossary, simplified instructions in video format, and improved how well the methodology flowed by expanding the moderator's role to act more as a facilitator and, thus, save teams time and resources. Additionally, if teams desire the methodology in a more simplified form in order to concentrate on the "big picture" as participant feedback noted, they can engage in the brainstorming stage only; if they think they need more detail, they can choose to move to the second brainstorming stage.

3.6 Applying the ASGD Methodology in Practice

Finally, to further evaluate the ASGD methodology, we used it in practice to identify and resolve potential design shortcomings. Our e-learning team, based at a large urban North American university, used the ASGD methodology for the concept-development stage to help develop and articulate concepts for two serious games.

The first game, *Accessibility Maze* (https://de.ryerson.ca/wa/maze.html), introduces learners to Web accessibility barriers that may prevent some people from accessing digital content. Subject matter experts (SME) and instructional designers (ID) developed the game's objectives before the brainstorming exercise.

The ASGD workshop led to two ideas for storytelling, such as using an adventure game that comprised mini quests and viewing the game through the main character's perspective to build empathy for people who face digital accessibility barriers. In the game-development stage, the team distilled these ideas into a final game proposal. During meetings, ideas generated in the concept-development stage had to undergo changes due to time, budget, and technology constraints. Although the team kept the empathy factors and the game adventure ideas with mini quests, the final game version included traps and puzzles that originated from the ASGD workshop. The team successfully tested the game and released it in April, 2020. It subsequently received the WebForAll 2021 Accessibility Challenge Award, and several educational institutions included it in their Web accessibility training material. In the first six months after its deployment in this material, users had played it over 3,700 times.

The feedback from players highlighted the educational game's high quality and that it successfully helped them learn. Players' comments such as "it was a fun experience! It will definitely help me make my website more accessible" indicate that the game supported learning through fun. Also, players felt that storytelling and adventure effectively taught accessibility content (e.g., "I thought this was an absolutely incredible way to get technology accessibility into a more digestible message").

The second game, called *Academic Integrity in Space* (https://www.torontomu.ca/academicintegrity/), focused on academic integrity awareness training. The team focused on replacing existing video tutorials with an SG that would improve learning outcomes. The SG user experience test indicated participants' agreement about being totally immersed with playing the game and validated its usability. Our team conducted a follow-up study to compare the effectiveness of academic integrity training tools designed with (i.e., Academic Integrity in Space game) and without (i.e., pre-existing video tutorials) the application of the ASGD methodology. Results from 249 participants in a controlled experiment showed significantly higher ($p < 0.01$) learning outcomes (academic integrity knowledge quiz score) for individuals who learned through the learning tools designed with the ASGD.

When designing the *Accessibility Maze,* the team initially allowed technological considerations from the start. As a result, while the team produced game drafts that functioned well on a gameplay level, it lacked engaging or flowing educational content. Thus, the team needed to start the brainstorming process again. This time, the team followed the ASGD methodology. From this process, the team produced a game with a different plot, environment, and mechanics than initially envisioned. More importantly, the final game provided a more challenging and, consequently, more engaging experience than the initial brainstormed game. Thus, not following the ASGD at the beginning meant that the team lost time and resources, while technological considerations moderately restricted how creative the team could be in the brainstorming stage. Interestingly, when designing the *AI in Space game*, the design team followed the ASGD methodology and produced in-depth LFPs based on the team brainstorming in a timely manner. After the team felt satisfied that the LFPs provided all the details and that they linked all the ideas, the team made technological decisions. Once the team determined all technological details, the SG game moved to post brainstorming where the team wrote the script for the game.

4 Discussion

Our results show that the ASGD methodology (which we based on the DPE framework) can benefit design teams in the concept-development stage when designing serious games. Our approach to developing concepts for SG design presents specific benefits that may appeal to multidisciplinary SG design teams because it enhances communication between team members through design artifacts such as ideation cards and glossary, which ensure equal input from team members in brainstorming and decision-making. Additionally, ideation cards can overcome the tendency to adopt ad hoc processes or methods based on personal experience as card questions quickly provide a focal point and common purpose for a serious game. Also, the brainstorming follows an uninterrupted flow due to the randomized order in which teams draw cards. The cards allow teams to quickly consider an idea, debate it, and either accept, reject, or postpone it. Furthermore, the ASGD methodology provides team members with clear roles so that they can develop core ideas in the first brainstorming stage and integrate them with the learning and game objectives in the second brainstorming stage before moving to actual development (see Table 2).

The ASGD methodology allows for effective communication, time management, team role allocation, and enhanced brainstorming. Compared to other SG design frameworks, the ASGD provides multidisciplinary

teams with a practical and tangible method for initiating efforts to design serious games in the concept-development stage—a stage where game ideas remain fluid and abstract, and linear SG design frameworks further obstruct their shaping. Therefore, compared to other SG frameworks, ASGD methodology approach offers fluidity and tangibility via its artifacts, which makes it an asset for a design team.

Additionally, the gamified aspect of the ASGD methodology through artifacts engages an SG design team right from the start and leads to intense interaction and communication during brainstorming. The methodology motivates teams to compose their collective ideas into a visual artifact—the LFP. In our pilot workshop, only one of the two design teams successfully completed an LFP within the given timeframe when using the DPE framework, and the completed LFP lacked the detail we expected. Therefore, we found the ASGD methodology to be advantageous as compared to the DPE framework because it enhances brainstorming and communication in a short timeframe.

Further, we validated the important role that concept design plays in the SG design process through empirical evidence from our user studies using the academic integrity learning tools: when we compared the tools, developers designed with the ASGD with the video-based tools that developers designed in an ad hoc fashion, the former had significantly better learning outcomes ($p < 0.001$). This evidence supports Garcia et al.'s (2020) suggestion that better-integrated learning objectives with a given activity's objectives lead to better learning outcomes. Therefore, learning tools developed using best practices in instructional and multimedia design can help teams design learning activities and lead to significantly more effective learning tools than those designed without considering those practices. In this respect, the ASGD not only provides an alternative design approach to multidisciplinary teams for the concept-development stage but also highlights the important role that concept development itself plays in a successful and enhanced SG design and development process.

Researchers developed most frameworks in the literature using the research-then-transfer rather than industry-as-laboratory approach as Potts (1993) describes. Potts proposed that one should prefer the latter approach because the need for the research originates from problems identified from close involvement with industry. We created the ASGD methodology in response to a problem that we directly experienced via continuous evaluation and improvement in real-life settings.

With regard to the ASGD's departure from the DPE framework, a structured, gamified approach to SG design, without following a linear process, allows teams to streamline their ideas quickly during the concept development stage and, thus, produce a solid and detailed LFP that can serve as a strong foundation for a serious game. Additionally, excluding developers from the initial brainstorming creatively benefits the brainstorming process since it allows team members to ideate more freely in line with the principle that technology mediates rather than drives learning (Bower, 2008, p. 39).

Lastly, by observing how design teams used the ASGD to design and develop in practice, we witnessed the important role that creativity and brainstorming play in the concept development, stage when technological considerations do not restrict them. During the post-brainstorming (development) stage, implementing these ideas in a serious game may depend on budgetary considerations and, therefore, may change. However, because the ASGD records the team's thought process, the methodology gives teams greater control over changes or revisions, which means they can implement the changes/revisions in a timely manner and without straining a game's budget.

4.1 Limitations and Further Research Directions

As with any study, this one has some limitations we must mention. The study's limitations primarily relate to methodological and practical issues. Despite significant findings, one should interpret our results with caution due to the small sample size. Further, to obtain more variance in the data, one could replace the five-point Likert scale with a seven-point scale in the future.

We found that students were more successful in learning the target material (i.e., academic integrity) by using a game based on the concept developed through the ASGD compared to learning methods based on an older concept. While this initial assessment proved promising, more research needs to assess whether the knowledge gained through a concept resulting from the ASGD persists better over time in comparison to knowledge gained from more traditional teaching approaches.

Further, our initial results suggest that alternative learning tools developed using the same concept lead to

similar learning outcomes; therefore, the game concept seems to be a serious game's most dominant aspect when it comes to desired learning outcomes. We view this finding as a theoretical contribution, we have reason to believe that decisions and choices that design teams make in further game-development stages would lead to engagement and entertainment differences in a game. Researchers need to conduct more theoretical and experimental work to determine the most effective mapping of SG design decisions (and their successful implementation) to "game play outcomes".

More research also needs to identify the extent to which technology poses limitations on transferring brainstormed ideas into a real game. Additionally, evaluating a serious game that a team designed with the ASGD methodology during gameplay would demonstrate how exactly the game's characteristics improved intended learning. Further evaluating LFPs that resulted from the ASGD methodology with established coding schemes (e.g., Heintz et al., 2015) would further help design teams refine a newly designed SG in a short timeframe. Further research into whether or not to include technical developers in the initial SG concept-development stage can provide more insight into how team composition affects the concept-development stage in the SG design process.

We built the ASGD methodology for an educational context as it focuses on linking learning objectives with game objectives. Nevertheless, one could adapt it to areas beyond learning, such as for therapy, recruitment, and corporate training by replacing the *learning* in the ASGD framework with a component relevant to a specific field; the inner circle would represent the given field's main objective, the outer circle would represent the desired outcome, and the middle circle would represent how one could achieve a given outcome (e.g., achieving treatment via observations and therapeutic activities following a diagnosis). One could adapt the questions on the cards related to the *learning* component with the given field's methods (e.g. therapeutic method) and replace resources with a learning focus with any suitable framework.

5 Conclusion

Organizations recognize serious games' value as educational tools or as entertaining educational means to support the learning process. In this paper, we report on an effort to develop and evaluate the ASGD methodology for multidisciplinary teams to use in the concept-development stage when developing a serious game. Our findings suggest that ASGD helps teams design serious games for education. As a result, by using the ASGD methodology, organizations can design a game concept for specific target audiences in-house without having to outsource the game-design process or choose an already existing serious game that might lack relevance to their specific learning goals.

The ASGD methodology can streamline concept development and, consequently, the SG design process by allowing teams to communicate effectively and enabling them to think creatively in a guided and practical manner. On the other hand, the methodology needs more refinement in terms of its usefulness for a team that varies in SG design experience. More experienced SG designers may resist adopting a new methodology, while novice SG designers may experience a dilemma: Should they learn from their experienced colleagues or follow a methodology? Thus, as with many design artifacts used for technical development, the methodology's value lies in the fact that all team members must be open to using a new approach in system development.

Acknowledgments

We thank eCampusOntario for funding this research project the framework of supporting innovation in applied research in technology-enabled learning. We also acknowledge and thank the following people who have been involved in this project: Dr. Tony Bates (The Chang School, Toronto Metropolitan University), Dr. Alexander Ferworn (Department of Computer Sciences, Toronto Metropolitan University), Dr. Daria Romaniuk (Daphne Cockwell School of Nursing, Toronto Metropolitan University), Margaret Verkuyl (School of Community and Health Studies, Centennial College), and Dr. Paula Mastrilli (Post Graduate Nursing Programs, George Brown College). Special thanks to the Digital Education Strategies (DES) team at Toronto Metropolitan University for their support in coordinating the research activities, including instructional design, Web development, video production, and editing.

References

Amory, A., (2007). Game object model version II: A theoretical framework for educational game development. *Educational Technology Research and Development, 55*(1), 51-77.

Anderson, B., Anderson, M., & Taylor, T. (2009). New territories in adult education: Game-based learning for adult learners. In *Proceedings of the 50th Annual Adult Education Research Conference.*

Anderson, L. W., & Krathwohl, D. R., (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives* (6th ed.). Longman.

Annetta, L. A. (2010). The "I's" have it: A framework for serious educational game design. *Review of general psychology*, *14*(2), 105-113.

Arnab, S., Lim, T., Carvalho, M. B., Bellotti, F., De Freitas, S., Louchart, S., Suttie, N., Berta, R., & De Gloria, A. (2015). Mapping learning and game mechanics for serious games analysis. *British Journal of Educational Technology*, *46*(2), 391-411.

Aslan, S., & Balci, O. (2015). GAMED: Digital educational game development methodology. *Simulation 91*, 307-319.

Athavale, S., & Mohan, A., (2018). Understanding game ideation through the lens of creativity model. In *Proceedings of the 5th International Conference on Design Creativity.*

Baboo, S., Kanna, Y., & Bennett, C. N. (2022). A systematic review on the neuro-cognitive correlates of game-based learning in higher education learning environments. In C. Lane (Ed.), *Handbook of research on acquiring 21st century literacy skills through game-based learning* (pp. 58-77). IGI Global.

Beranič, T., & Heričko, M. (2022). The impact of serious games in economic and business education: A case of ERP business simulation. *Sustainability, 14*(2), 1-17.

Bellotti, F., Berta, R., & De Gloria, A. (2010). Designing effective serious games: Opportunities and challenges for research. *International Journal of Emerging Technologies in Learning, 5*(SI3), 22-35.

Bower, M. (2008). A pedagogy-first approach to teaching learning design. In *Proceedings of the LAMS and Learning Design Conference.*

Brandão, J., Ferreira, T., & Carvalho, V. (2012). An overview on the use of serious games in the military industry and health. In M. M. Cruz-Cunha (Ed.), *Handbook of research on serious games as educational, business and research tools* (pp. 182-201). IGI Global.

Calik, A., & Kapucu, S. (2022). The effect of serious games for nursing students in clinical decision-making process: A pilot randomized controlled trial. *Games for Health Journal*, *11*(1), 30-37.

Carvalho, M. B., Bellotti, F., Berta, R., De Gloria, A., Sedano, C. I., Hauge, J. B., Hu, J., & Rauterberg, M. (2015). An activity theory-based model for serious games analysis and conceptual design. *Computers and Educ*ation, *87*, 166-181.

Chamberlin, B., Trespalacios, J., & Gallagher, R. (2012). The learning games design model. *International Journal of Game-Based Learning, 2*(3), 87-110.

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. *Review of Educational Res*earch, *86*(1), 79-122.

De Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers and Education, 46*(3), 249-264.

De Freitas, S., & Neumann, T. (2009). The use of "exploratory learning" for supporting immersive learning in virtual environments. *Computers & Education*, *52*(2), 343-352.

Deng, Y., Antle, A. N., & Neustaedter, C. (2014). Tango cards: A card-based design tool for informing the design of tangible learning games. In *Proceedings of the Conference on Designing Interactive Systems.*

Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: Two case studies of Active Worlds as a medium for distance education. *British Journal of Educational Technology*, *36*, 439-451.

Djaouti, D., Alvarez, J., Jessel, J. P., & Rampnoux, O. (2011). Origins of serious games. In M. Ma, A. Oikonomou, & L. C. Jain (Eds.), *Serious games and edutainment applications* (pp. 25-43). Springer.

Dwivedi, A. K., Mallawaarachchi, I., & Alvarado, L. A. (2017). Analysis of small sample size studies using nonparametric bootstrap test with pooled resampling method. *Statistics in Medicine*, *36*(14), 2187-2205.

Food and Drug Administration. (2020). *FDA permits marketing of first game-based digital therapeutic to improve attention function in children with ADHD*. Retrieved from https://www.fda.gov/news-events/press-announcements/fda-permits-marketing-first-game-based-digital-therapeutic-improve-attention-function-children-adhd

Gaikwad, V., Rake, R., & Kumar, V. (2022). Serious games market by gaming platform, application, industry vertical and region: Global opportunity analysis and industry forecast, 2021-30. *Allied Market Research.* Retrieved from https://www.alliedmarketresearch.com/serious-games-market

Garcia, I., Pacheco, C., Méndez, F., & Calvo-Manzano, J. A. (2020). The effects of game-based learning in the acquisition of "soft skills" on undergraduate software engineering courses: A systematic literature review. *Computer Applications in Engineering Education, 28*(5),1327-1354.

Godoy, A., & Barbosa, E. F. (2010). Game-scrum: An approach to agile game development. In *Proceedings of SBGames*.

Groff, J., Clarke-Midura, J., Owen, V., & Rosenheck, L. (2015). *Better learning in games: A balanced design lens for a new generation of learning games.* MIT Education Arcade and Learning Games Network.

Gunter, G. A., Kenny, R. F., & Vick, E. H. (2006). A case for a formal design paradigm for serious games. *The Journal of the International Digital Media and Arts Association, 3*(1), 93-105

Habgood, M. J., Ainsworth, S. E., & Benford, S. (2005). Endogenous fantasy and learning in digital games. *Simulation & Gaming*, *36*(4), 483-498.

Hagen, U. (2009). Where do game design ideas come from? Invention and recycling in games developed in Sweden. In *Proceedings of the DiGRA International Conference.*

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behav*ior, *54*, 170-179.

Hanson, W. E., Creswell, J. W., Plano Clark, V. L., Petska, K. S., & Creswell, J. D. (2005). Mixed methods research designs in counseling psychology. *Journal of Counseling Psychology, 52*, 224-235.

Heintz, M., Law, E. L. C., & Soleimani, S. (2015). Paper or pixel? Comparing paper and tool-based participatory design approaches. In *Proceedings of the 15th IFIP TC 13 International Conference.*

Hirumi, A., & Stapleton, C. (2008). Applying pedagogy during game development to enhance game-based learning. In C. Miller (Ed.), *Games: Purpose and potential in education* (pp. 127-162). Springer.

Hokkanen, I. (2015). *Bloom taxonomy: Action verbs and Activities*. Retrieved from https://www.slideshare.net/IidaHokkanen/bloom-taxonomy-action-verbs-and-activities

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI Workshop on Challenges in Game AI*.

Iten, N., & Petko, D. (2016). Learning with serious games: Is fun playing the game a predictor of learning success? *British Journal of Educational Technology, 47*(1), 151-163.

Ke, F. (2016). Designing and integrating purposeful learning in game play: A systematic review. *Educational Technology Research and Development, 64*, 219-244.

Kirjavainen, A., Nousiainen, T., & Kankaanranta, M. (2007). Team structure in the development of game-based learning environments. In *Proceedings of the DiGRA International Conference.*

Korhonen, T., Halonen, R., Ravelin, T., Kemppainen, J., & Koskela, K. (2017). A multidisciplinary approach to serious game development in the health sector. In *Proceedings of the 11th Mediterranean Conference on Information Systems.*

Kuittinen, J., & Holopainen, J. (2009). Some notes on the nature of game design. In *Proceedings of the*

DiGRA International Conference.

Kultima, A., (2010). The organic nature of game ideation: Game ideas arise from solitude and mature by bouncing. In *Proceedings of the Academic Conference on the Future of Game Design and Technology*.

Landers, R. N., & Callan, R. C. (2011). Casual social games as serious games: The psychology of gamification in undergraduate education and employee training. In M. Ma, A. Oikonomou, & L. Jain (Eds.,) *Serious games and edutainment applications* (pp. 399-423). Springer.

Lo, P., Thue, D., & Carstensdottir, E. (2021). What is a game mechanic? In *Proceedings of the International Conference on Entertainment Computing.*

Manker, J., & Arvola, M. (2011). Prototyping in game design: Externalization and internalization of game ideas. In *Proceedings of the 25th BCS Conference on Human Computer Interaction.*

Mehta, A., Bond, J., & Sankar, C. S. (2022). Developing an inclusive education game using a design science research gestalt method. *AIS Transactions on Human-Computer Interaction*, 14(4), 523-547.

Morell, L., & Tan, R. J. B. (2009). Validating for use and interpretation: A mixed methods contribution illustrated. *Journal of Mixed Methods Research*, *3*(3), 242-264.

Moser, C., Tscheligi, M., Zaman, B., Vanden Abeele, V., Geurts, L., Vandewaetere, M., Markopoulos, P., & Wyeth, P. (2014). Editorial: Learning from failures in game design for children. *International Journal of Child-Computer Interaction*, *2*(2), 73-75.

Mueller, F., Gibbs, M. R., Vetere, F., & Edge, D. (2014). Supporting the creative game design process with exertion cards. In *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems.*

Müller, R. M., & Thoring, K. (2011). Understanding artifact knowledge in design science: Prototypes and products as knowledge repositories. In *Proceedings of the Amerias Conference on Information Systems.*

Musil, J., Schweda, A., Winkler, D., & Biffl, S. (2010). Improving video game development: Facilitating heterogeneous team collaboration through flexible software processes (pp. 83-94). In A. Riel, S. O'Connor, S. Tichkiewitch, & R. Messnarz (Eds.), *Communications in computer and information science.* Springer.

Ørngreen, R., & Levinsen, K. (2017). Workshops as a research methodology. *The Electronic Journal of E-Learning, 15*(1), 70-81.

Petri, G., von Wangenheim, C. G., Borgatto, A. F., Calderón, A., & Ruiz, M. (2022). Digital games for computing education: What are the benefits? (pp. 1571-1598). In IRMA (Ed.), *Research anthology on developments in gamification and game-based learning.* ICG Global.

Pilote, B., & Chiniara, G. (2019). The many faces of simulation. In G. Chiniara (Ed.) *Clinical simulation* (pp. 17-32). Academic Press.

Potts, C. (1993). Software-engineering research revisited. *IEEE Software, 10*, 19-28.

Rooney, P. (2012). A theoretical framework for serious game design: exploring pedagogy, play and fidelity and their implications for the design process. *International Journal of Game-Based Learning, 2*(4), 41-60.

Tekinbas, K. S., & Zimmerman, E. (2003). *Rules of Play: Game design fundamentals*. MIT Press.

Schell, J. (2008). *The art of game design: A deck of lenses*. CRC press.

Schoonenboom J., & Johnson R. B. (2017) How to construct a mixed methods research design. *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, *69*(Suppl 2), 107-131.

Silva, F. G. M. (2019). Practical methodology for the design of educational serious Games. *Information, 11*(1), 1-13.

Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games. *Personnel Psycholo*gy, *64*(2), 489-528.

Sonnenberg, C., & Brocke, J. V. (2011). Evaluation patterns for design science research artefacts. In: M. Helfert & B. Donnellan (Eds.), *Practical aspects of design science* (CCIS vol. 286). Springer.

Thoring, K., Mueller, R., & Badke-Schaub, P. (2020). Workshops as a research method: Guidelines for designing and evaluating artifacts through workshops. In *Proceedings of the 53rd Hawaii International Conference on System Sciences.*

Treiblmaier, H., Putz, L. M., & Lowry, P. B. (2018). Setting a definition, context, and theory-based research agenda for the gamification of non-gaming applications. *AIS Transactions on Human-Computer Interaction, 10*(3), 129-163.

Tschang, T. F., & Szczypula, J. (2006). Idea creation, constructivism and evolution as key characteristics in the videogame artifact design process. *European Management Journal, 24*(4), 270-287.

Vlachopoulos, D., & Makri, A. (2017). The effect of games and simulations on higher education: A systematic literature review. *International Journal of Educational Technology in Higher Education*, *14*, 1-33.

Vogel, J. J., Vogel, D. S., Cannon-Bowers, J., Bowers, C. A., Muse, K., & Wright, M. (2006). Computer gaming and interactive simulations for learning: A meta-analysis. *Journal of Educational Computing Research, 34*(3), 229-243.

Wetzel, R., Rodden, T., & Benford, S. (2017). Developing ideation cards for mixed reality game design. *Transactions of the Digital Games Research Association*, *3*(2), 1-17.

Wiggins, G., & McTighe, J. (2005). *Understanding by design* (2nd ed.). ASCD.

Wilson, K., Bedwell, W., Lazzara, E., Salas, E., Burke, C., Estock, J. L., Orvis, K. L., & Conkey, C. (2009). Relationship between game attributes and learning outcomes: Review and research proposals. *Simulation & Gaming 40*(2), 217-266.

Winn, B. M. (2009). The design, play, and experience framework. In R. Ferdig (Ed.), *Handbook of research on effective electronic gaming in education* (pp. 1010-1024). IGI Global.

Wouters, P., van Nimwegen, C., van Oostendorp, H., & van Der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology, 105*(2), 249-265.

Zarraonandia, T., Diaz, P., Aedo, I., & Ruiz, M. R. (2015). Designing educational games through a conceptual model based on rules and scenarios. *Multimedia Tools and Appl*ications, *74*(13), 4535-4559.

Appendix A: Major Design Models

Table A1. Major Design Models

Theory/authors	Framework key characteristics/ features	Key shortcomings
Mechanics, dynamics, and aesthetics framework (MDA) (Hunicke et al., 2004)	• MDA framework focuses on the interaction between the designer and the player that results in gameplay • It comprises mechanics, dynamics, and aesthetics • MDA allows a design team to focus on the experience or emotion that it wants to evoke and choose the appropriate game genre and game mechanics. • Its creators designed MDA as an analytical tool for digital games	• Although a foundation for SG design, the framework does not incorporate learning objectives • Strong focus on game mechanics makes it unsuitable for different game types • Weak in linking game components in SG design as its creators created it for entertainment games
Four-dimensional framework (4DF) (de Freitas & Oliver, 2006)	• The 4DF approaches SG design through four dimensions: learner specifics, pedagogy, context, and representation. • It focuses on synthesizing each dimension's components • It addresses the multidisciplinary nature of design teams by assigning dimensions to individual roles	• Although it incorporates learning as a SG design framework, it is abstract • Fails to align game characteristics • Does not provide to design teams (where to start, check, finish)
Exploratory learning game design model (ELGDM) (de Freitas & Neumann, 2009)	• ELGDM includes elements from both 4DF and ELM (de Freitas and Jarvis 2006) • It has a strong learning-centered design focus. • it fuses game design with participatory design and evaluation strategies.	• Fails to align game characteristics • Although it incorporates learning as SG design framework, it does not provide a practical design approach and operational methodology to multidisciplinary design teams
Learning games design model (LGDM) (Chamberlin et al., 2012)	• LGDM adopts holistic approach to design process with collaborative team effort • LGDM 1) ensures that design teams produce educational goals and outcomes appropriate to the learner, 2) ensures that they become immersed in both content and game design, and 3) allows for extensive testing with the target audience.	• Dependence on consensus between team members' theoretical approach to learning • Cost and time needed to develop games • Does not provide comprehensive evaluation data about using the model • Lacks an accompanying process methodology for linking learning outcomes to game objectives and task allocation for SG design team members
Balanced design framework (BDF) (Groff et al., 2015)	• The BDF concentrates on the balanced alignment between content, task, and evidence (and the assessments) in a game that quantifies the learning • It integrates effective practices in game design by helping designers to align learning goals with game mechanics • The BDF provides design process approach	• BDF's strong focus on assessment may undermine other game design aspects (e.g., storytelling) • BDF lacks a detailed process for how teams should apply the framework to designing serious games and what steps they should take

Table A1. Major Design Models

Learning mechanics and game mechanics mapping framework (LM-GM) (Arnab et al., 2015)	• The LM-GM model allows design teams to discover and understand how various game mechanic properties relate to learning mechanics or pedagogical objectives. • The model maps a game mechanics list onto a learning mechanics list. It calls the game components that translate the theoretical learning objectives into game mechanics "serious game mechanics" (SGMs). • Researchers have evaluated the model for its usability and ability to help one analyze serious games with positive results. • The model provides a design process approach	• Its creators designed LM-GM for analyzing and not designing serious games. • When a design team uses LM-GM to design a serious game, it may face restrictions in choosing activities for specific learning outcomes. • LM-GM does not provide step-by-step guidance on how to initiate SG design process and does not allocate roles to team members.

Appendix B: ASGD Artifacts

Ideation Cards

Ideation cards facilitate and support collaborative design (Wetzel et al., 2017), provide a structure, and reinforce discussions. Ideation cards can foster a shift of focus when discussions become unproductive (Mueller et al., 2014). Additionally, cards allows design teams to externalize their ideas (Deng et al., 2014) in a playful but structured manner and have the potential to facilitate problem solving by fostering collaboration among team members. Therefore, they represent highly appealing design tools for multidisciplinary game design teams.

We divided the ASGD cards into four categories that each represent game design's components as the ASGD framework shows. Each card contains a question/statement related to the game design property. Some cards deliberately repeat some questions in the first two brainstorming stages to allow teams to refine ideas before designing the LFP. As Figure A1 shows, the card deck design represents the SG design components and depicts objects or activities that symbolize these components. The decks use hand-drawn art to appeal to team members and motivate them to engage in collaborative brainstorming.

Figure A1. Card Deck Representing the Four Components of Serious Game Design

On the front, the cards include a keyword derived from the ASGD framework with question(s) that teams should consider when brainstorming. A color in the ASGD framework and the front card border symbolizes each game design property. Some questions contain keywords in bold to prompt team members to peruse their accompanying glossary to ensure they comprehend terms in a similar manner.

The ASGD framework separates the cards into two groups: a deck with the solid border for the first brainstorming stage that focuses on generating design ideas with all game components and a deck with striped borders for the second brainstorming stage that focuses on further developing design game ideas and helping team members refine game details across game components. The second brainstorming stage represents a unique characteristic of the ASGD methodology because it allows team members to clarify and refine ideas: by asking key questions once again, the ASGD methodology enables team members to record responses from different roles and perspectives and, in turn, review and integrate them into a game.

Figure A2. Example of Cards from Brainstorming Stages 1 and 2

Card-drawing Rules

The ASGD framework has simple rules for using the cards: teams divide the cards by category and appoint a reader and writer. Team members choose the first card randomly, discuss the theme, and, if they reach agreement, write the answer on a sticky note and attach it to the corresponding section of the ASGD framework on an A0 size poster. If the team members cannot agree on a decision, they place the card aside and chooses another one. Team members can draw only two cards from the same category in a row so that they can brainstorm and expand their ideas across the four categories. Also, the framework invites team members to add their own questions if needed. Team members record all answers on sticky notes in colors corresponding to a specific category, which they place in the corresponding section in the ASGD framework poster. To allow for iteration between the first and second brainstorming stages, some cards ask the same questions. When team members feel confident that they have completed brainstorming, they design a low-fidelity prototype.

Figure A3. ASGD Framework Poster

Glossary

The ASGD glossary serves as a communication bridge between team members as it explains technical terms listed in the ideation cards in simple terms. The glossary ensures that the whole team understands a concept, action, or issue during brainstorming in the same way. Each entry in the glossary derives from a bolded card question, which prompts team members to make sure that they understand a term in the same way.

About the Authors

Naza Djafarova is the Director of Digital Education Strategies at The G. Raymond Chang School of Continuing Education, Toronto Metropolitan University. She has a Master's Degree in Architecture and completion of postgraduate qualification PhD program on Management: Social and Economic Systems. Recently, Naza completed her Masters of Science in Information Technology Management at Toronto Metropolitan University. Her thesis research focused on flow and motivation in serious games. Naza actively participates in Toronto Metropolitan University Academic research projects and recently became a Lead Researcher for innovation in applied research in technology-enabled learning. She leads projects on design and development of serious games that have received international awards.

Anastasia Dimitriadou is a researcher at The Chang School of Continuing Education, Toronto Metropolitan University. Her background is in social sciences with a strong interest in game-based learning and lifelong education. She holds a PhD in the Sociology of Education from UCL Institute of Education, has previously taught social sciences and has extensively researched issues in education and health. Her current research interests focus on game-based learning, social interaction, human computer interaction, and educational technology.

Leonora Zefi is a seasoned education management professional with experience in online and hybrid curricular design and teaching and faculty development. She has been involved in multi-institutional research work related to faculty development, open infrastructure and serious game design. In 2021, Leonora led the establishment of the Learning Experience Design Lab that focuses on development, implementation and evaluation of learning design models and technologies to support curricular innovation. Leonora is passionate about open and inclusive learning and teaching. She holds a Master of Educational Technology Degree from University of British Columbia and a Bachelor of Education in Adult Education from Brock University.

Ozgur Turetken is a professor and associate dean at the Ted Rogers School of Management at Toronto Metropolitan University. Prior to Toronto Metropolitan University, he served on the faculty of Temple University's Fox School of Business and Management. His main research interests are in applied (text) analytics, especially in the context of individual decision making and users' interaction with analytics solutions. His research on the organization and presentation of information as they relate to decision outcomes and user experiences has led to over 50 publications in international journals and conferences, and has been funded by NSERC and SSHRC among other agencies. He is also active in HCI and analytics research communities as an editor and track chair, he holds a PhD in Management Science and Information Systems from Oklahoma State University.

Transactions on Human - Computer Interaction