Towards a Serious Games Design Framework for People with Intellectual Disability or Autism Spectrum Disorder

Stavros Tsikinas, Stelios Xinogalos

Abstract

Designing serious games (SGs) for people with intellectual disability (ID) and autism spectrum disorder (ASD), requires proper planning and decision making. In this article, a proposal of a serious games design framework (GDF) that aims to assist designers and special education teachers and professionals develop successful SGs for people with ID and people with ASD, is presented. In order to create this GDF, an extraction of SGs design guidelines from existing SGs for people with ID and ASD and a comparative analysis with common GDF that are used for designing SGs in general was conducted. The proposed design guidelines and the conclusions of the comparative analysis of existing general purpose GDFs were used as a tool to design a computer-based SG that aims to improve independent living skills of people with ID and people with ASD. Based on this previous work the proposed GDF that is analyzed in this article was devised. This work aims to fill the gap in the field of designing SGs for people with ID and ASD by providing a specialized and informed GDF.

Keywords

1. Introduction

Serious Games (SGs) are videogames that fulfill additional purposes rather than just entertainment. SGs have been successfully integrated in many disciplines, such as education, health, military and advertisement (Michael and Chen, 2005). Especially in education, technological tools, such as SGs, have enhanced the learning process in different fields and levels (Connolly et al., 2012). Lately, there has been an effort of using SGs in special education in the process of acquiring skills important in a human's life (Tsikinas and Xinogalos, 2019a). SGs can be used in special education both for supporting the teaching and learning process of typical school subjects, but also for improving various conceptual, social, practical and

intellectual functioning skills. Although the research presented in this article refers to SGs targeted to special education in general, the main focus is on SGs for improving the aforementioned skills.

The target group of the SGs under investigation consists of people with Intellectual Disability (ID) and people with Autism Spectrum Disorder (ASD). A person with ID has limitations in adaptive and intellectual functioning skills, whereas a person with ASD has significant limitations mainly in social interaction skills and emotion recognition (Tsikinas et al., 2016). Although these developmental disorders mainly exist separately, there are occasions where they co-exist in a person.

In order to educate people with ID and people with ASD, researchers and educators have implemented different teaching methods. Role playing is followed extensively by special education teachers, in order to address mainly social skills in a more engaging way, compared to more traditional techniques (Bremer and Smith, 2004). Another technique that is followed in special education mainly for social skills is the individual or group conversation sessions (Wehmeyer et al., 2003). Special education professionals also include free-play in classrooms, to identify behavior during play and interactions with peers (Anderson et al. 2004).

Regardless of the learning techniques that educators follow, people with ID and ASD have special requirements that need to be met, during learning. Due to the fact that people with ASD have limited interests, using them as motivators could enhance the learner's engagement (Mancil and Pearl, 2008). Furthermore, researchers have identified that adding the element of repetition in learning can benefit people with ASD (Moore et al., 2005). Finally, educators should define clear and personalized goals for people with ID and ASD, in order to assist them acquire or improve the addressed skills (Polychronopoulou, 2010).

Technological means, such as educational software or SGs, have been successfully used in special education of people with ID and people with ASD (Tsikinas and Xinogalos, 2019a). To develop a successful SG the design phase of the game should be treated importantly. In this phase, different aspects of the game should be taken care of, such as the technology used, the learning objectives and the graphical user interface. Therefore, game design frameworks (GDFs) have been proposed to serve game designers and developers in designing successful SGs. GDFs include all the elements that should be included in a SG, in order to fulfill the defined learning objectives. Although, several GDFs for general purpose SGs are available, the existence of

frameworks for designing SGs targeted to people with ID and people with ASD is still an open issue.

This paper aims to present a GDF that will assist designers and developers in creating SGs for people with ID and people with ASD, but also general purpose SGs. Section two presents the methodology followed for devising the proposed GDF, which was heavily based on relevant work of researchers in the field, as well as our own previous work. Section three presents our proposed framework, while section four analyzes it in the context of existing general purpose GDFs. Finally, some conclusions are drawn and proposals for further research in the field are presented.

2. Literature Review and Methodology

In this section a literature review on the subject under investigation is presented, along with the methodology for constructing the proposed GDF for SGs targeted to people with ID and ASD. The methodology used is summarized in Figure 1.
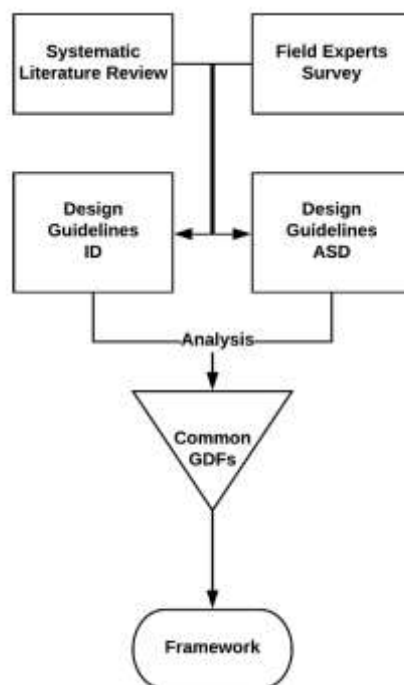

Figure 1. Steps followed in the creation of the framework.

The first step of the process was a *systematic literature review* (SLR) on the effects of SGs on people with ID or ASD (Tsikinas and Xinogalos, 2019a). This work covered also aspects of the design, implementation and evaluation process of SGs for people with ID or ASD. The design methodology utilized was presented in a limited number of studies. Although these studies did not provide details for the design process, it became clear that involving end users or professionals in the field of special education in the design process of SGs for people with ID and ASD is considered important. This is usually accomplished by using the *participatory design* method or a similar *user-or learner-centered* approach. The SLR also showed that existing studies for people with ID do not cover entirely the skills of adaptive behavior or intellectual functioning skills, as defined by the American Association on Intellectual and Developmental Disabilities (AAIDD). The same is true for SGs that address conceptual skills, such as understanding money and time, as well as practical skills addressing schedules or routines, use of telephone, and work-related skills for people with ASD (Tsikinas and Xinogalos, 2019a).

The results of the SLR provided motivation for investigating the perceptions of special education teachers and professionals regarding the use of SGs for improving the various skills defined by AAIDD. An *on-line survey* was selected as a data collection tool in order to record the perceptions of more special education teachers and professionals than we could physically approach. The survey intended to investigate the perceptions of special education teachers and professionals on the *effectiveness* and *usefulness* of SGs as teaching/learning tools, their *ease of use* and the *ideal age group* for each one of the skills defined by AAIDD (Xinogalos and Tsikinas, 2019). It is clear that the questions regarding the usefulness, ease of use and effectiveness included in the survey correspond to the factors of perceived usefulness, perceived ease of use and attitude toward using a new information technology defined in the best known Technology Acceptance Model (TAM) by Davis (1989). However, since we wanted to investigate the three aforementioned factors for each one of the thirteen skills defined by AAIDD in addition to other issues, a general five-point Likert scale question was used for each factor instead of the set of questions proposed in the model. The rest of the survey was designed by the authors taking into account relevant literature. The questionnaire was validated by two experts, one from the field of Special Education and one from the area of Computer Science and Educational Technology. An email with the aim of this study along with a link for the questionnaire (Google form) was sent to the principals of all the special education primary and

secondary schools and institutions in Greece. Our aim was to distribute the survey to all the special education professionals and teachers working in schools/institutions all over Greece. Ninety-three special education professionals and teachers participated in the study by filling anonymously the on-line questionnaire. The participants evaluated positively SGs for all the skills defined by AAIDD regarding their usefulness, usability and effectiveness, as indicated by the mean values and percentages calculated for the corresponding questions. In Table 1 the participants' perceptions on the age group that SGs for each skill should be ideally targeted are presented, based on the percentages calculated for each skill and age group. Further details can be found in (Xinogalos and Tsikinas, 2019).

Table 1. Appropriateness of SGs targeted to specific skills of people with ID and ASD.

Skill	Age 5-13		Age 14-24	
	ID	ASD	ID	ASD
Adaptive behavior: Conceptual Skills				
Letters	√	√		
Money			√	√
Numbers	√	√		
Language	√	√		
Adaptive behavior: Social Skills				
Emotions		√	√	
Social Interaction		√	√	
Adaptive behavior: Practical Skills				
Safety			√	√
Diet	√	√		
Hygiene	√	√		
Travel, Transportation			√	√
Work-Related			√	√
Intellectual Functioning				
Perception	√	√		
Rules	√	√		

Lately, the participatory approach has become widespread in the SGs design community (Ismail, Ibrahim and Yaacob, 2019), because game designers need to have prior knowledge of the domain that the game addresses (Khaled and Vasalou, 2014). Therefore, the participatory approach was also adopted as part of our research methodology. Field experts could provide us with significant and valuable information, regarding existing learning methods and practices that are followed in special education that could assist in the development of a GDF targeted to people with ID/ASD. However, when people with ID/ASD are included in the design of a SG

several challenges and ethical issues are raised, as will be analyzed in the analysis of the proposed GDF.

Due to the fact that designing SGs for people with ID and ASD is a challenging task and a specialized design framework was not located, several SGs were studied. This study aimed to obtain valuable information on good design practices that are either explicitly or implicitly described in related work. Based on this analysis a set of *design guidelines* were extracted for SGs targeted to people with ID (Tsikinas and Xinogalos, 2018) and ASD (Tsikinas and Xinogalos, 2019b). These design guidelines are presented in Table 2. From Table 2 it is obvious that most of the proposed design guidelines are common for people with ID and ASD.

Table 2. Design guidelines for SGs targeted to people with ID or ASD

Design guidelines	References for ID	References for ASD
Participatory design *can lead to a better SG*	(Bargagna et al., 2014; Brown et al., 2011; Politis et al., 2017)	(Bernardini, Porayska-Pomsta & Smith 2014; Piper et al., 2006)
Simple graphical user interface *with clear and cartoonish graphics* *and clear font text*	(Bonet-Codina, von Barnekow & Tost, 2015; Hofmann, A., Hoppe, I., & Jantke, 2010; Lanyi & Brown, 2010; Lanyi, Klung & Szücs, 2014; Lopez-Basterretxea, Mendez-Zorrilla & Garcia-Zapirain, 2014)	(Bamasak et al., 2013; Perera et al., 2014; Rahman, Ferdous & Ahmed, 2010; Ribeiro & Raposo, 2014; Yan, 2011)
Audio-visual feedback *should be preferred to textual feedback*	(Bargagna et al., 2014; Everhart, Alber-Morgan & Park, 2011; Freina, Bottino & Tavella, 2016)	(Christinaki, Vidakis & Triantafyllidis, 2014; Daouadji-Amina & Fatima, 2018; Ribeiro & Raposo, 2014; Yan, 2011)
Progressing game difficulty *keeps players'sense of motivation and* *challenge*	(Bottino et al., 2014; Djaouti, Alvarez & Jessel, 2011; Weiss, Bialik & Kizony, 2003)	(Tan, Harrold & Rosser, 2013; Tanaka et al., 2010)
Personalization *of various game elements, such as* *characters, environment, gameplay or* *even feedback is necessary*	(Corrales-Astorgano et al., 2016; Curatelli & Martinengo, 2012; Hussaan, Sehaba & Mille, 2011; Torrente et al., 2012; Weiss, Bialik & Kizony, 2003)	(Caria et al., 2018; Chang et al., 2012; Deriso et al.m 2012; Fridenson-Hayo et al., 2017; Garzotto et al., 2014; Ribeiro & Raposo, 2014)
Monitoring *players' progress & providing* *assistance*	(Bargagna et al., 2014; Corrales-Astorgano et al., 2016; Lopez-Basterretxea, Mendez-Zorrilla & Garcia-Zapirain, 2014)	-
Motivators *should be used (in or out of the SG) to* *keep people with ASD engaged and* *motivated*	-	(Garzotto et al., 2014; Kerns et al., 2016)

Repetition *can be used to make the experience motivating and enjoyable for people with ASD*	-	(Afonseca & Badia, 2013; Daouadji-Amina & Fatima, 2018; Davis et al, 2007; Kwon & Lee, 2016)

Along with recording design guidelines for SGs targeted to people with ID and ASD based on the literature, existing general purpose *GDFs were studied* in order to investigate whether they incorporate somehow the design guidelines that were extracted from the literature and consequently they could be utilized in designing SGs for people with ID and ASD. A summary of the axes/layers and the corresponding elements of the examined GDFs is presented in Table 3.

Table 3. Serious games design frameworks

Framework	Axes/Layers	Elements
Conceptual Framework (Yusoff et al., 2009)		Capability, Instructional content, Intended learning outcomes, Game attributes, Game genre, Game mechanics, Game achievement, Learning activity, Reflection, Feedback
Serious Educational Game (SEG) Design Framework (Annetta, 2010)		Identity, Immersion, Interactivity, Increased complexity, Informed teaching, Instructional
Four-dimensional Framework (de Freitas & Jarvis, 2006)	Context	Place, Access, Tech support
	Representation	Immersion, Representation, Fidelity, Level of interactivity
	Pedagogy	Situative, Associative, Cognitive
	Learner	Demographics, Preferences, Group, Skills
Educational Games (EG) Design Framework (Ibrahim & Jaafar, 2009)	Game design	Usability, Multimodal, Fun-challenge
	Pedagogy	Learning outcomes, Motivation theory, Self-learning, Problem-solving
	Learning content modeling	Syllabus matching, Scaffolding
Design, Play, Experience Framework (Salen & Zimmerman, 2004)	4 layers with 3 attributes for each one related to the designing team (D), game experience (E) and players (P):	
	Learning	Content and pedagogy (D), Teaching (E), Learning (P)
	Storytelling	Character, setting and narrative (D), Storytelling (E), Story (P)
	Gameplay	Mechanics (D), Dynamics (E), Affect (P)
	User experience	User interface (D), Interactivity (E), Engagement (P)

SG design framework for people with autism (Khowaja & Salim, 2019)	Input	Autism behaviors & symptoms, Desirable capabilities, Learning outcomes, Instruction contents
	Process – Learning Activities	Reflection, Instruction method, Instructional strategies, Game genre, Game mechanics, Game dynamics, Game story (Storytelling, Narratives, Characters), Game-based learning attributes, Modalities
	Output	Debriefing, User achievements, User profile

Although some of the design guidelines are part of existing GDFs, there are some guidelines that are not present at any GDF and also there is no single GDF that incorporates all of them. For example, some features, such as the graphical user interface, feedback and progressing difficulty exist more or less in every GDF. However, in the case of SGs for people with ID or ASD the graphical user interface must be simpler; the feedback must be audio-visual instead of textual; and so on. Personalization, monitoring, and motivators are less frequent in general-purpose GDFs, while repetition seems to be missing. Participatory design is an inherent feature only in the "Design, Play, Experience Framework" (Salen and Zimmerman, 2004). This means that existing GDFs do not cover all the requirements of designing SGs for people with ID or ASD. One solution would be to use an existing GDF along with the proposed design guidelines or devising an informed GDF that incorporates all the required design guidelines.

In this sense, the extracted design guidelines were utilized along with the "Serious Educational Game (SEG) Design Framework" (Annetta, 2010) for *designing a SG* for people with ID and ASD in order to validate and revise them. Although, any of the reviewed general purpose GDFs could be utilized, the SEG design framework was selected mainly due to the fact that the identity of the player is its core element, but also a key factor when designing didactical interventions for people with ID and ASD. However, it must be stated that any of the reviewed GDFs could have been utilized. The SG designed is a role-playing game (RPG) for helping students and young adults with moderate or low ID and high functioning ASD acquire and improve independent living skills, such as hygiene, transportation, money management and work-related skills (Tsikinas et al., 2019). An important conclusion that was drawn from designing the aforementioned SG, which certainly needs to be further investigated, is that although people with ID and ASD have differences the SGs targeted to them have common features and consequently a SG that incorporates personalization and adaptation mechanisms can be used by both groups. Furthermore, during the design process of the game it became clear that the proposed guidelines provide insights for several important issues, such as monitoring the progress of players with ID

or providing motivators and repetition possibilities for players with ASD or personalization features both for players with ID and ASD. However, these design guidelines have to be complemented with other important issues that are present in general purpose GDFs, such as clearly defining the learning goals of a SG and carrying out usability testing for investigating the acceptance of a new SG by its target group.

Table 4 presents the elements in our framework and the elements of the analyzed GDFs. For each one of the elements of our framework, the corresponding element or axis of the analyzed frameworks is presented. The elements of the proposed framework will be analyzed in the next section, while a comparison of this framework with existing GDFs will be presented in the Discussion section.

Table 4. The elements of the proposed GDF and existing GDFs.

Our Framework	Conceptual Framework (Yusoff et al., 2009)	4-Dimensional Framework (de Freitas & Jarvis, 2006)	EG Design Framework (Ibrahim & Jaafar, 2009)	SEG Design Framework (Annetta, 2010)	Design, Play, Experience Framework (Salen & Zimmerman, 2004)	Design Framework for SG in Autism (Khowaja & Salim, 2019)
Pedagogy		Pedagogy	Pedagogy		Learning	
Learner		Learner		Identity	Learning	User profile & achievements
Educator					Learning	
Participatory Design					*implied by the process*	
Learning Objectives	Intended Learning Outcome	Learner	Learning Content Modelling		Learning	Intended learning outcomes
Learning Content & Game Mechanics		Representation			Learning	
Immersion	Game Attributes	Representation	Game Design	Immersion	Storytelling	Storytelling
Personalization		Representation				
Self-learning	Reflection		Pedagogy		User Experience	User profile and achievements
Continuous Challenge			Game Design	Increasing Complexity	User Experience	
Evaluation			Game Design	Informed Teaching		Debriefing

Usability Testing	Game Design
Game Learning Analytics	Informed Teaching

3. The Framework

The proposed GDF includes elements that need to be included in the design of SGs for people with ID and people with ASD. Although this framework has been used to design a serious game targeted to young adults with ID and ASD, it could also assist game designers in developing games for different purposes. The layout of the design framework is shown in Figure 2. The framework consists of three main axes: pedagogy, learning content & game mechanics and evaluation. Each one of these axes is equally important in the design of a SG for people with ID and people with ASD. The arrows define the route of the process. The bubbles indicate on which design guideline is the element based on.
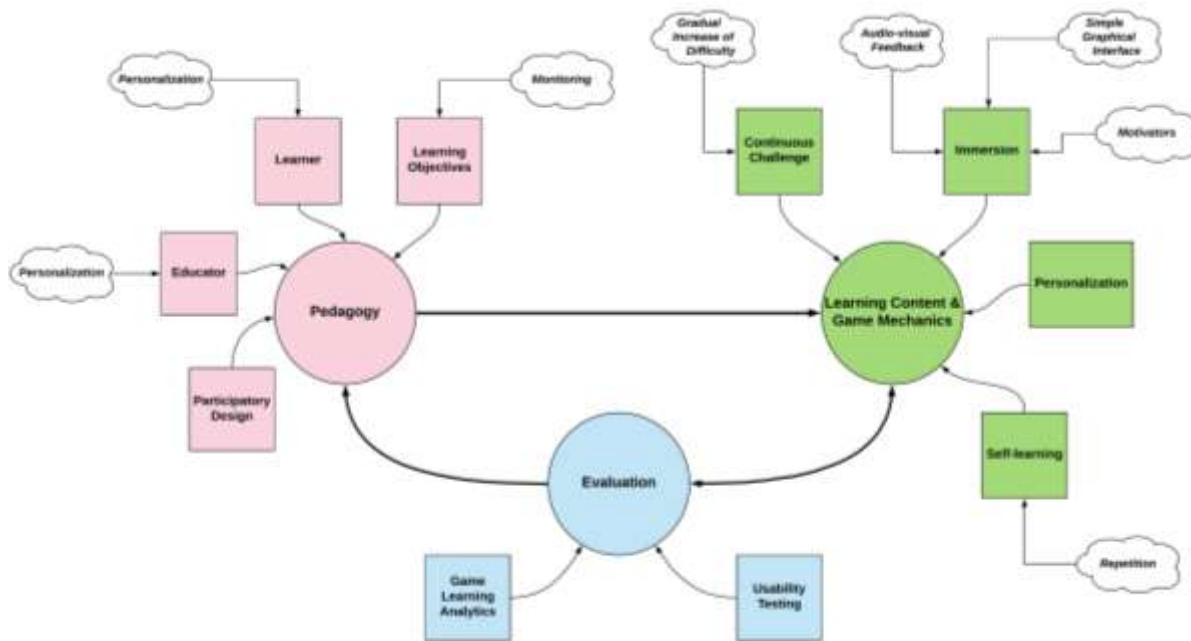

Figure 2. The proposed SG design framework for people with ID or ASD.

3.1 Pedagogy

The first axis of the proposed GDF is Pedagogy. The main goal of a SG in education is to enhance the learning process of a subject and to provide an alternative and more "fun" way of acquiring knowledge. In order to design a successful SG for people with ID and people with

ASD it is important to actively include the educators and learners in the process and to define clear goals (Tsikinas and Xinogalos, 2018; 2019b).

3.1.1 Participatory Design

A SG is successful, when the learning purpose is fulfilled, in a transparent manner. Otherwise, the players might forfeit (van Staalduinen and de Freitas, 2011). In order to achieve it, researchers try to actively include field experts in the design process of the game. Participatory design consists of theories, studies and practices of a software or hardware solution, where the end-users and stakeholders actively participate in the design activities (Muller, 2009). In SGs for people with ID and people with ASD, participatory design is successfully performed, by including special education teachers and professionals, but also potential users (Bargagna et al., 2014; Bernardini, Porayska-Pomsta and Smith, 2014; Brown et al., 2011; Piper et al., 2006; Politis et al. 2017). By expressing opinions and participating in the design sessions, people with ID and people with ASD can improve their social and communication skills, feel more self-confident and feel useful (Robb, Waller and Woodcock, 2019). Participatory design is usually applied by conducting interviews and using questionnaires with special education teachers and professionals and by prototype playtesting sessions with potential users.

Although the participatory design approach is considered effective, it must be stressed that it is also challenging and raises various ethical issues, especially when it entails people with ID and ASD. As Slegers, Duysburgh, and Hendriks (2015) state, people living with impairements have different experiences and moreover express themselves diferently. This means that various participatory design methods and tools suffer in terms of their inclusiveness when dealing with people with ID or ASD. For example, the informed consent form is not always possible to be signed by an impaired participant and if it is signed by the participant's next-of-kin then achieving the desired equivalence between all participants is hampered (Slegers et al., 2015). Moreover, the stackeholders are many (teachers, professional carers, medical experts, phsycologists, parents, partners, people with ID/ASD) and usually have conficting or at least different viewpoints and balancing them is rather challenging (Slegers et al., 2015). Although, it is beyond the scope of this work it must be stated that on the one hand participatory design is proposed when dealing with SGs for people with ID/ASD but on the other hand applying it poses researchers and game designers with various challenges and ethical considerations that should be known in advance and further researched.

3.1.2 Learner

People with ID and people with ASD face greater difficulties in acquiring skills, compared to people with typical development (Tsikinas et al., 2016). Hence, as target audience in a gaming solution, it is important to identify and understand their behavior and symptoms. Each person with ID or ASD has a different set of behaviors that should be considered carefully in the design phase of a SG (Khowaja and Salim, 2019; Snell et al., 2009). Also, in studies related to teaching and learning methods utilized for educating people with ID and people with ASD, the importance of individualizing the learning process is mentioned (Iovannone et al., 2003). To achieve this, researchers and educators apply the principles of *differentiated instruction* (Tomlinson, 2000). To ensure proper use of differentiated instruction, educators should assess the general learning experience of a student, taking into consideration the progress of the personalized goals that have been set. According to Tomlinson (2000), the main principles of differentiated instruction are Content, Process, Product and Learning Environment. The educational goal that the students must accomplish and the way that they will access the relevant information in order to acquire knowledge are included in content. Process refers to the ways that engagement to the content is achieved by the students and educators can assess, such as through the use of SGs in our case. When the process is complete, the students demonstrate what they have learnt, i.e. the product. Finally, to apply differentiated instruction in a classroom, the learning environment should be set in a way that suits the content, process and product. Differentiated instruction is also applied in special education and is considered an important element that could effectively enhance the learning process (Ernest et al., 2011).

Therefore, promoting a *personalized* experience in a SG is an important feature. As shown in Table 2, many existing SGs for people with ID and people with ASD use personalized and customizable content, to motivate the players and improve their engagement. The most common content that is customizable in existing SGs for people with ID and people with ASD is the protagonist's appearance (Deriso et al., 2012; Fridenson-Hayo et al., 2017; Torrente et al., 2012). Another element that according to researchers enhances the sense of uniqueness is the option to customize the environment, such as the level aesthetics and graphics of the game (Caria et al., 2018; Garzotto et al., 2014; Hussaan, Sehaba and Mille, 2011).

3.1.3 Educator

The role of special education teachers and professionals in the learning process of people with ID and people with ASD is of vital importance. The *personalized goals* of a person are defined by the teachers and the progress to meet them is monitored. Therefore, it is important to include special education teachers and professionals in the design phase of a SG. They can define the *requirements*, *goals* and *learning objectives* of the game. Also, special education teachers should have a significant role in the process, since the solution would be used as a tool to enhance the learning process, in the appropriate context.

3.1.4 Learning Objectives

Learning objectives are defined by the educators, in order to set goals for their curriculum. Learning objectives consist of goals that educators want the learners to reach (van Staalduinen and de Freitas, 2011). In the design process of a SG, defining the learning objectives is crucial, since they can determine the game itself. For example, a SG that aims to improve social skills of people with ASD should consist of different game elements and game mechanics from a SG that aims to improve understanding of the concept of money in children with ID. The learning objectives, however, should be created based on what the learner would learn and not what the learner will accomplish in the game. For example, successfully completing all the levels of a SG, does not explicitly mean that the learning process was successful, according to van Staalduinen and de Freitas (2011). In order to monitor the progress of fulfillment of the learning objectives in a SG, *monitoring techniques* should be followed to collect valuable data of the game, regarding effectiveness and efficiency. Through monitoring, the educators and researchers are able to identify possible issues that may arise and make changes in the game (if applicable) or in the learning method that is followed (Bargagna et al., 2014).

3.2 Learning Content & Game Mechanics

When using a game in a learning environment, the educator provides the "fun" factor to the process (Squire, 2011). To promote fun in a SG, designers create game content that is appropriate for the learning objectives and suitable for the target audience (learners). In the GDF the element of content includes important components, necessary to design an immersive

experience for people with ID and people with ASD and at the same time help them achieve the underlying learning objectives.

3.2.1 Immersion

Engagement is a vital part of a successful SG, because the players are motivated to continue the game experience and enhance the sense of immersion. When the players are engaged to the game, they are motivated to complete the game and meet the game goals and the learning goals (Annetta, 2010).

An important element, for achieving immersion in SGs for people with ID and people with ASD, is the use of a *simple graphical user interface*. If the graphical user interface is complex, the users might feel overwhelmed and forfeit the game (Lopez-Basterretxea et al., 2014) or be distracted (Boleracki et al., 2015; Lanyi and Brown, 2010) and abandon the experience.

Another game mechanic that promotes immersion *is audio/visual feedback*. In SGs for people with ID and people with ASD, feedback is used to encourage the players and to keep the engagement level high (Christinaki, Vidakis and Triantafyllidis, 2014; Everhart, Alber-Morgan and Park, 2011; Freina, Bottino and Tavella, 2016). According to Kiili (2005), the use of immediate and appropriate feedback in a game-based learning experience, can lead to the state of total immersion and engagement, defined as *flow*. The state of flow is important in the design of a SG for people with ID and people with ASD, in order to minimize boredom and distraction.

Another way of enhancing immersion is to include the game element of *reward*, is SGs. Reward is used, apart from immersion-related reasons, in order to help the players achieve long-term goals, by providing a more personalized experience (Whyte, Smyth and Scherf, 2015). On the other hand, in the learning process of people with ASD, educators use *motivators*, to engage the learners in the activity (Tsikinas and Xinogalos, 2019b). Motivators can be used in a SG, through different ways. One example of rewards that can motivate learners in a gaming experience is by adding in-game prizes (coins or benefits) (Kerns et al., 2016). Especially for people with ASD, motivators could be irrelevant to the game, such as listening to a favorite song or watching a favorite movie or video (Garzotto et al., 2014).

3.2.2 Personalization

Although people with ID and people with ASD have common symptoms, their limitations and behavior may vary. Therefore, when designing learning activities for people with ID and people with ASD, the element of individualization and personalization should be considered carefully (Tsikinas and Xinogalos, 2018; 2019b). SGs for people with ID and people with ASD should include different personalized features (Curatelli and Martinengo, 2012). The use of *personalized content* in a SG can increase engagement and immersion and therefore become successful. For example, defining the appearance of the protagonist of the game, endorses the sense of uniqueness to the players (Tsikinas and Xinogalos, 2018). Personalized features can be irrelevant to the representation of the game, such as adjusting game difficulty, according to player's performance (Curatelli and Martinengo, 2012; Weiss, Bialik and Kizony, 2003).

3.2.3 Self-learning

Allowing the players to explore the game by themselves and providing them with freedom of choices, is an element that enhances the experience and engages the players. Also, one of the characteristics of people with ASD is the repetitive behavior (Lord et al., 2018) and consequently a player with ASD might want to repeat a task in the game although s/he has accomplished it. In SGs for people with ID and people with ASD, the element of failure is not preferred, because it is possible to demotivate them and forfeit the game. Therefore, a SG should allow players to retry in case of failure or if they are willing to achieve a better score (Afonseca and Badia, 2013; Daouadji-Amina and Fatima, 2018; Davis et al, 2012; Kwon and Lee, 2016).

3.2.4 Continuous Challenge

There is an important balance between challenge and skills that game designers should consider, in order to create a pleasant game experience and reach the state of flow (Kiili, 2005). Challenge is one of the main reasons players play videogames in general (Lucas and Sherry, 2004). Therefore, since a SG is a videogame, we consider the element of challenge important in a GDF. Researchers in SGs for people with ID and people with ASD have included the game mechanic of *gradual increase of complexity and difficulty* in the games, in order to keep the players motivated, but also to provide them with *continuous challenge* (Bottino et al., 2014; Djaouti,

Alvarez and Jessel, 2011; Tan, Harrold and Rosser, 2013; Tanaka et al., 2010; Weiss, Bialik and Kizony, 2003).

3.3 Evaluation

When a SG for people with ID and people with ASD is designed, an important phase of the design is to evaluate the design decisions, in order to proceed with the implementation of the game, in the intended context. Therefore, this axis provides the features that should be considered by designers, while evaluating the design of a SG for people with ID and people with ASD.

3.3.1 Usability Testing

One of the core features that a SG should have is the acceptance of the potential players. If the game is not accepted by them, the game is considered failed. Furthermore, people with ID and people with ASD are considered a very specific target audience and the evaluation should be treated as such (Tsikinas and Xinogalos, 2018). *Usability testing* is a technique that could determine the satisfaction and efficiency of the developed SG of the target audience (learner and educator) (Olsen, Procci and Bowers, 2011). Through usability testing, designers can identify possible implications of the game and re-design specific game elements and mechanics. Therefore, it would be helpful to include play-testing sessions when evaluating a prototype of a SG for people with ID and people with ASD and observe their experience (Afonseca and Badia, 2013). A different way of satisfaction and efficiency evaluation that is followed in SGs for people with ID and people with ASD are structured or un-structured interviews with the learners and the educators after the experience (Ribeiro and Raposo, 2014). Researchers also conduct usability testing sessions with typical education students, in order to obtain further insight (Parsons, 2015).

3.3.2 Game Learning Analytics

In order to observe, measure and analyze the learning activities, researchers use the mechanism of learning analytics. Recently there has been an increase in the interest regarding the use of these measurements in the context of a SG, known as *Game Learning Analytics* (Cano,

Fernández-Manjón and García-Tejedor, 2018; Freire et al., 2016). People with ID and people with ASD have limitations in communication skills and therefore, expressing their opinion might be a challenge. Moreover, recording players' actions and analyzing them after the end of the game is a time consuming and difficult task. By obtaining information regarding the game and the learning process at the moment it takes place, using the tool of game learning analytics can be profitable.

4. Discussion

The proposed GDF is created to assist game designers and special education teachers and professionals in developing SGs targeted to people with ID and people with ASD. However, we believe that the framework could be effectively used to develop SGs in general, with the appropriate adjustments.

The initial step of the framework is to define the pedagogical elements of the SG that will be developed. Through this phase, the designers and stakeholders could have the foundation of the final solution. When these elements are agreed and determined, the learning content and game mechanics are created, i.e. the aesthetics and the mechanisms to reach the state of flow. When the game is designed, there are sessions of evaluation, in order to determine whether the game prototype is accepted or not. If not accepted, refactoring steps need to be taken in pedagogical issues, learning content and game mechanics, to improve the game. Therefore, the process of designing SGs for people with ID and people with ASD should be an iterative process, in order to be successfully designed.

In previous studies (Tsikinas and Xinogalos, 2018, 2019b), we have presented and analyzed common GDFs that have been used in the design of general purpose SGs, as previously mentioned. The elements of these GDFs are presented along with the proposed GDF in Table 4 presented at the end of section 2. Our framework is user/learner –centered and therefore participatory design is a core element. However, none of the analyzed GDFs explicitly includes participatory design in the process. The "Design, Play, Experience framework" is an exception, where this element is implied through the process.

Although most of the elements in our proposed GDF have been defined by the guidelines extracted in our previous work, there are others which are crucial in the design phase of a SG, in general and as such were incorporated in the revised GDF. Learning objectives define the goals

and learning outcomes of the game and should be included in a GDF. Usability testing is crucial in the development of a successful SG, because the designers are able to identify advantages and flaws of the developed SG and improve the game to satisfy the target audience.

As stated in previous work, we were not able to find a GDF that is targeted to SGs addressed to people with ID and people with ASD. Also, in existing SGs in the field, researchers mainly focus on guidelines and decisions, rather than a design framework. In this sense, we believe that our proposed framework could be important in the field of designing SGs for people with ID and people with ASD.

5. Conclusions

The development of a successful SG is challenging, because the balance between learning and fun is crucial. Especially in special education, the integration of SGs in the learning process is an important matter and therefore specific guidelines should be followed in the design phase. In this study we presented the steps that were followed that guided us to a new design framework that would help designers and developers in designing SGs for people with ID and people with ASD. The proposed GDF was used in the design of a SG that aims to improve independent living skills of students and young adults with ID and ASD. Although the game design framework is constructed based on elements and guidelines for people with ID and ASD, it is our belief that the framework could be used for designing general purpose SGs, with some possible modifications.

Plans for future research include validating the proposed SG design framework. As soon as a game prototype is implemented for the SG that was designed using the new framework, a usability session will be held with the target users, special education teachers and professionals. This will give us the chance to validate the framework and further revise it if necessary.

Moreover, it would be interesting to implement a web-based tool for presenting the proposed GDF and supporting special education professionals and game designers in preparing a game design document. Potential users will have the chance to interact with the elements of the GDF and be guided through the process, taking into account important requirements that must be met in order to design a SG that has the potential to assist people with ID and ASD. Moreover, a forum could be used in order to give researchers and game designers the chance to comment on the GDF and participatorily revise it.

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