Able to Create, Able to (Self-)Improve: How an Inclusive Game Framework Fostered Self-Improvement Through Creation and Play in Alcohol and Drugs Rehabilitation

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Abstract. We are working towards establishing a framework to enable more people to create and play digital games. Our focus is on skills, communication, and collaboration, since these qualities can enable more people to co-create inclusive games. In this paper, we describe how the framework assisted adults involved in an alcohol and drugs rehabilitation program to co-create their own games. Ten adults in a healthcare service co-created games using the framework as a part of their rehabilitation, in ten meetings spanning four months. Two healthcare professionals evaluated the activities. Five additional collaborators (three with a Computer Science and two with a Nursing background) provided accessibility features and artistic improvements to the projects. During the meetings, we observed that game creation and playing helped the participants. They started in an uncertain frame of mind, with low-self esteem, and were scared to use computers and games, since they doubted they could succeed. However, they ended up more confident on their abilities and proud of their creations, as they were able to share their games and knowledge with their peers, and teach people how to play. The models and systems of the framework allowed the people to achieve better results. The game co-creation empowered the participants, and, hence, their abilities became opportunities for further collaborations. Co-creation consisted of a journey in which self-improvement superseded the created games.

Keywords: End-User Development · Game Development · Game Accessibility · Universal Design · Meta-Design · Human-Centered Computing

1 Introduction

In the same way that traditional literacy defined reading and writing skills as being essential for gathering knowledge and communicating, digital games are

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now encouraging educators to seek modern types of literacy [8, 14, 18, 36, 48]. In light of this, we should, ideally, allow everyone to create and play them. However, there are still a limited number of audiences for game creation strategies. For instance, a systematic review of Game Based Learning found that only 6 out of 494 studies (1.21%) took account of a public who were, at least, 23 years old, while 351 studies (71.05%) targeted children, youngsters, and teenagers [8]. The review also comments that inclusion tended to focus on "*game making as a strategy for addressing the underrepresentation of girls and women in computing*" [8].

Our analysis of academic studies that describes the end-user development of digital games obtained similar results. In particular, young Anglophone students (normally children and teenagers attending elementary and high schools in the United Stated of America; for instance, in [1, 5, 6, 7, 9, 17, 18, 21, 22, 24, 26, 29, 32, 34, 35, 36, 41, 45, 47, 48, 54, 57]) seem to be most often the intended audience for the design and evaluation of game creation strategies. Modder (people who modify their favourite games) communities were the second most common audience (for instance, in [42, 43, 55]). Although older (the average age of the participants was 31 years old in [42]), modders grew up playing digital games. The term "average users" [11, 38] describes users belonging to a group with a normal distribution of skills, but excluding, for instance, users with disabilities, a low level of literacy, or who are older. Thus, to the best of our knowledge, the usual audiences (average users) for game creation and modding are young people within a normal distribution of user abilities and interaction needs.

When investigating the potential barriers to game creation and playing (for instance, age, socioeconomic status, literacy, language, and (dis)abilities), audiences of potential creators can be found that have not yet been included. Game accessibility provides resources that can help developers to enable more people to play [3, 10, 13, 15, 20, 59]. Although these studies are currently aimed at professional developers, another route for inclusion can be explored, by fostering inclusive co-creation as a means of enabling people with heterogeneous interaction needs to make their own games, by encouraging creation and use alike. This could benefit key areas such as education and healthcare. For instance, healthcare professionals can exploit these games as rehabilitation tools that can allow their patients to address their mental, physical, and behavioral condition [2, 27, 28, 44]. Thus, by selecting suitable strategies, domain experts (such as healthcare professionals and educators) could explore game creation as well as playing the games themselves to assist their activities.

In an attempt to be more broadly inclusive, our framework has been defined to promote the inclusive co-creation of digital games. Our lemma is "games *by* everyone, *for* everyone". However, this lemma and our goals do not assume that everyone will be able to create and play every game. Rather, it means that we should always strive for inclusion: even if a system cannot become universal, it can always become more inclusive. The framework aims at extending modding to "accessibility modding", and, thus, allow people to add content as well as accessibility features to promote inclusion.

In this paper, we describe how our framework has helped participants who are currently digitally (and socially) marginalized to create and play digital games, by including their peers and becoming changed in the process. Some adults in an alcohol and drugs rehabilitation program in a public healthcare service (Psychosocial Care Center – Alcohol and Drugs; in Portuguese, Centro de Atenção Psicossocial – Álcool e Drogas (CAPS/AD)) used our framework as a support activity for their rehabilitation so that they could create and play their own games[1]. In the process, creation became a "sandbox", in which participants designed games for self-expression and to share their experiences and knowledge with others. Ultimately, the framework enabled them to create and play for a greater end, by providing participants with opportunities for self-expression, learning, and growth.

2 A Framework Towards Inclusive Game Co-Creation

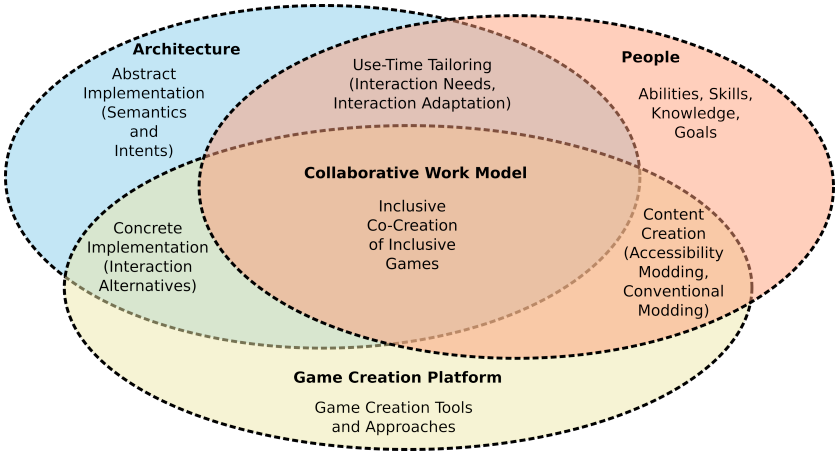
To achieve broader inclusion, there is a need to focus game creation on abilities, knowledge and skills, and provide opportunities for collaboration based on what people are able to do. In this way, people with heterogeneous interaction needs can start contributing, co-creating, and playing games. In particular, it should be noted that the interaction needs of the creators may be different from those of the players. Thus, inclusion should encompass creation (game making) *and* play (the resulting games).

We have defined a framework to enable people with heterogeneous abilities to work with communities, and co-create accessibility features for inclusive play. This involved overcoming barriers, by providing better communication, collaboration, and inclusion in a combined collective effort to cater for individual needs. These requirements were met based on three key pillars: (i) a flexible software architecture that allows use-time modification of human-computer interaction; (ii) a collaborative working model that can turn inclusion into a community problem (that is, it can be addressed by the collaboration of the community); (iii) tools to create the workflow. As proof of concept, these tools are, currently, accessible to a subset of interaction needs (traditional audiences, hearing disabilities, and a low rate of literacy) and a single genre (storytelling).

The architecture enables developers to implement games for adaptation, based on "semantics of use" rather than physical-level activities (what a player can do, instead of how she/he will do it). These adaptable systems were called tailorable games. Like tailors, we create and adjust the input and output (IO) interaction that can suit a player's ability to command and follow the game based on her/his interaction needs. Our use-time tailoring architecture allows an arbitrary re-definition of human-computer interaction at the time of use. It explores game entities and components (from Entity-Component Systems [16, 33, 40]),

[1] As end-users (including people with disabilities and/or situations of vulnerability) took an active part in our study, we complied with research ethics protocols throughout the entire process. Certificado de Apresentação de Apreciação Ética from Plataforma Brasil: CAAE: 89477018.5.0000.5504.

Fig. 1: The pillars of the framework supporting people.



events and event handlers (from Event-Driven Architectures [16, 33, 40]), and data-driven architectures ([16, 33]) so that interaction alternatives can be introduced to (or removed from) a game at run-time [12, 13]. As a result, interaction becomes similar to plug-and-play add-ons for game accessibility. This approach lets developers address different interaction needs iteratively, one audience a time, to allow the creation and play.

With this architecture, a "one core fits most" version as well as multiple accessible game versions can co-exist in the same digital system. Developers can create interfaces to suit the needs of the widest range of people, as well as custom interfaces for specific interaction needs. The users can choose and combine alternatives to define their best way of interacting with the system. For instance, text, audio, video, and/or graphics can convey a given entity; controllers, assistive technologies, and/or automation can handle it. With this architecture, players can choose which features they want for their game and define the customized ways of playing, based on their own needs. Thus, access can be given to new audiences; a better experience of use, usability and interaction choices can be provided for those already included.

The collaborative working model makes use of the architecture for both game creation and modding, by providing a dynamic and iterative process to scaffold community-powered inclusion. We applied the communist slogan "*from each according to their abilities, to each according to their needs*" [30] to game creation: the architecture allowed people to add new content to a game, co-creating inclusion as a community. The community can improve inclusion (through accessibility modding), as well as content (through conventional modding). In this way, the end-users can provide broader accessibility even if the original developers failed to do so. The members of the community can provide their own abilities, knowledge, and skills to create and improve the content of the game *and* provide accessibility features so that it can be played by new audiences. Thus, collaborative

practices (such as modding, co-design [37, 58] and co-creativity [23, 51, 52, 60]) can be employed towards co-creation of inclusion and game content. As a result, the people who are included can further co-create and enable new people to play, by forming "cycles of inclusion" based on their abilities. Rather than being excluded, the people become "yet to be included". Once they have been included, they are potentially able to enable new audiences to co-create and play.

As the end-users are not, necessarily, programmers, tools are needed for inclusive end-user creation of tailorable games. As a proof of concept, we implemented Lepi for storytelling-based games. Lepi currently caters for traditional audiences, people with hearing disabilities (by providing graphics and text content for all kinds of media, and sign language support such as videos) and people with low literacy (by providing audio descriptions, large icons, and audio voice recordings).

Figure 1 outlines strategies explored in the framework to support people. The collaborative working model is the inner part of the figure, as it merges people, the architecture and the game creation platform into a system that can assist end-user game creation. The other parts cooperate in the co-creation of tailorable games. Interaction needs result from the architecture and people (for instance, disabilities) to provide interaction alternatives. The intersection between the architecture and the game creation platform abstract this task into slots for accessible content (for instance, audio-description, closed-captions, translations, alternative input devices, graphical, aural or haptic effects). Slots represent placeholders for interaction alternatives to convey an item of information. The intersection between people and the game creation platform represents how people create and implement the alternatives. Once someone creates an alternative, she/he can add the artifact into its slot (from drawings, voice recordings, text, sign language videos, or other media). In this way, the resulting game can combine features to produce accessible versions for different audiences of players.

3 Fostering Self-Improvement Through Game Creation and Play With Adults in Alcohol and Drugs Rehabilitation Programs

Ten meetings were held in the CAPS/AD, spanning a period of four months. These were concerned with end-user game creation and playing activities and how to evaluate and refine the framework. The service was designed to assist the rehabilitation of adults suffering from alcohol and drug addiction. Our meetings became an additional activity provided by the service with the aim of helping its users. They followed a similar pattern: (i) They started with a brief description of the planned activities. (ii) They completed a cycle of the collaborative working model, consisting of: (1) **Conception**: idealization of the project; (2) **Conversion**: first prototype of the game; (3) **Evaluation**: evaluation and guidance from the Supervisor; (4) **Creation**: development of the game; (5) **Enrichment**: improvement of the game's features and usability, inclusion of accessibility alternatives; (6) **Distribution**: assembling of playable games; (7) **Use**: play sessions

with other participants; (8) **Conclusion**: end of the project. The working model set out "transient roles", which were defined on the basis of what the participants were carrying out at a given time. They could be Supervisors, Creators, Collaborators, and Players. In particular, the Collaborators could act as Enablers (for instance, by providing accessibility features to enable others to create and play), and/or Enhancers (for instance, by improving the quality of existing features and thus refine the game). (iii) They finished by discussing the activities and results with the healthcare professionals to obtain feedback and inform them about the next meeting.

In the first meeting, we set out our project to the users of the CAPS/AD, and invited them to participate. The recruitment and meetings were held at the healthcare service center as a biweekly activity, and each lasted two hours. We explained our goals (refining and evaluating the framework, and employing game creation as a support therapy) to users of the service and provided a schedule of planned activities per meeting. Interested users of the service took part of their own free will, without any incentives or rewards. Attendance was optional (both at the activity and for the service itself).

From the second meeting onwards, the participants only interacted with games and our game creation platform. As most participants had never used a computer before, the second and third meeting involved playing games to teach them how to use the mouse and keyboard: a game designed to teach basic mouse skills [56], and a therapeutic game designed for elderly people with depression [39], and a visual novel in Portuguese (Carcará, by Supernova Games) at the third meeting. The visual novels emphasized the storyline rather than the other technical features (such as mechanics), and the storytelling was closer to traditional media (for instance, books, movies, and soap operas). This allowed the participants to create content from the third meeting, with an incremental introduction of more complex strategies and game mechanics (by exploring "gentle slopes" [4, 46] even within non-programming activities – for instance, from linear stories to non-linear, branching stories).

From the fourth meeting onwards, the participants stopped making use of the existing games and started to create their own. They used Lepi, our game creation platform, and exploited the working model to create, share, and play their games. Each meeting introduced new features and added complexity to the development process. This continued until the last two meetings, during which our participants showed their games to other users of the service, who had never taken part in our activities.

3.1 Participants and Their Goals

Our team consisted of the authors of this paper and three additional supporters (a MSc in Computer Science, and a undergraduate student and a PhD in Nursing). The supporters and two authors (undergraduate students in Computer Science) acted as Collaborators in the working model. Two CAPS/AD healthcare professionals assisted and monitored the meetings; they were involved in the research as Supervisors. In the case of the professionals, the meetings provided an

additional strategy for carrying out their responsibility of aiding the CAPS/AD's users. Finally, ten CAPS/AD users agreed to participate in our study (hereafter called participants). They were recovering from alcohol and drug abuse, receiving non-compulsory support (for instance, guidance to stop use and avoid lapses) at the service center. The participants were not hospitalized and were not surrogates. In the working model, they acted as Creators, Collaborators, and Players, depending on the different phases of the working model and activities that were carried out

The participants were adults (29 or older) from a lower socioeconomic background, with no programming experience, low literacy skills (ranging from not being able to read and write, to a primary level of literacy skills in Portuguese), and different computer skills (from never having used a computer before to being able to use office productivity suites). Emotionally-wise, they displayed a subset of features that are characteristic of young drug addicts described by Rodrigues et al. [49], such as: emotional vulnerability and insecurity, anxiety, low self-esteem and performance levels, internal and external pressures (their own, from colleagues, and from society), and a lack of self-confidence and hope. Unlike the young drug addicts however, they were not, for instance, aggressive, impulsive, and hyperactive. Owing to their cognitive and emotional condition, it was important to avoid situations that might lead to failure during their creative activities. Otherwise, the participants might assume they were unable to carry out activities, blame themselves (rather than the tools), and give up.

Figure 3 and Figure 2 illustrate some participants and created games. Table 1 outlines the motivations, needs, goals, and wishes of the participants and how the framework helped to achieve them. It provides a summary of the following subsections. The features and strategies in the table summarize how each pillar of the framework helped the participants to create and play games.

3.2 Becoming Able to Create: Exploiting the Framework to Suit the Interaction Needs of the Participants

Overall, the participants wanted to have opportunities and succeed (Goal 1.1 in Table 1), and also to feel they were members of society, as they felt excluded from it ("*I hear in the streets: 'you can't do that, because you are an addict, you are this, you are that'; no, we are not like that, we can do it*'"; "*I want to be able to do it*"; "*I can do it, I will be able to*"). Goal 1.1 became the ultimate goal of the study, which the framework had to support. The systems (Lepi and architecture) had to suit the interaction needs of the audience for creation and play. The Creators, Supervisors, and Collaborators had to work together to co-create games (work model).

The process to achieve the Goal 1.1 was incremental, and set out by enabling creation. The participants needed basic computer skills for this (Goal 1.2). Among the participants, there were people who had never used computers or played digital games before. Some were scared, and afraid they would be unable to interact with the computer ("*I never thought I would be able to use the computer; I had seen others using it, but never thought I would*"); others did

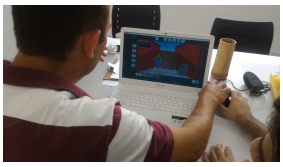
(a) Participants meeting each other at a room in the service.

(b) Two participants meeting at a town square.

(c) Game to promote the healthcare service. A person invites his friend to seek aid in the service.

(d) Scene resulting from seeking aid in the service, following Figure 2c.

Fig. 2: Examples of three games created by our participants using Lepi.



(a) P_2 creating his game.

(b) P_2 proud of his game.

(c) Participants creating their games.

(d) P_3 playing a game on which her image was not her.

(e) Supervisor helping a Creator.

(f) The Creator from Figure 3e decided to dictate his story.

Fig. 3: Participants creating and playing games over multiple meetings.

Table 1: Summary of how the framework supported the goals of the participants.

Goal	Participants needs/wishes	Pillar(s)	Framework features/strategies
1.1	Be able to succeed	A, M, L	Increase creation complexity over time (M, L); avoid creation errors (L)
1.2	Learn how to use computers	L	Prefer easier interactions (L)
1.3	Create the game	A, M, L	Provide alternatives for creation (A, M, L); promote external aid with Collaborators (M)
1.4	Help friends to play the game	A, M, L	Provide alternatives for use (A, L); promote creation of accessible content (M) and external aid (Collaborator) (M)
1.5	Understand what the game is presenting	A, M, L	Provide interaction alternatives (text, speech, sign) for play (A, L); promote creation of alternatives (M); explore aid for creation and play (M)
1.6	Be part (inside of) the game	M, L	Co-create image of participants (M); include images into game (L)
1.7	Be with friends in-game, in a common physic space	M, L	Co-create assets (M); inclusion of assets in game (L)
1.8	Show what was being learned in the service	M, L	Define game choices with different outcomes and scores (L); play and discuss games with domain experts (M)
1.9	Promote the healthcare service, removing negative stigmas	L	Co-create as marketing, game play as publicity (L)
1.10	Help players to develop character and values – especially kids	M, L	Co-create to teach (L); provide scores to provide feedback (L); play and discuss to learn (M)
1.11	Express ideas (share ideas in a different media)	M, L	Co-create for self-expression (L); supervision for evaluation (M)
1.12	Feel important, at least for a day	M, L	Co-create to self-express, demonstrate skills and knowledge, and demonstrate progress (L); validation from community use (M)
1.13	Learn with a game created by others	M, L	Play to experience creation from others, receive feedback from domain experts, and foster community discussion (M); scores to measure performance (L)
1.14	Understand what would happen after bad choices	M, L	Perceive outcomes from choices (L); receive advice, guidance, and support from main experts (M)
1.15	Share opinions, discuss similar experiences	M, L	Play to foster discussion (L); discuss with community and receive guidance from domain expert (healthcare professional) (M)
1.16	Share the game with friends (with different interaction needs)	A, M, L	Define interaction alternatives (M); include alternatives in project and export project as games with different accessibility features (A, L)
1.17	Share experiences and perceptions	M, L	Co-create to teach and self-express (L); share game to communicate with others (M)

Pillars: Architecture (A), Collaborative Work Model (M), Lepi (L)

not have access to computers ("*you know, it is a very good experience, because children in school have computers, and I was never able to have one*"), nor could afford to do computing courses ("*I never thought I would do a computing course in my life*"). The participants made their first contact and were provided with basic training by playing games to practice basic mouse and keyboard skills at the second and the third meetings.

At the fourth meeting, there began the creation activities based on the framework (Goal 1.3). The architecture made it possible to implement multiple IO schemes and interactions to suit the needs of our participants. Lepi provided abstract commands for creation (for instance, for adding media and characters, and editing the dialogues), that allowed us to implement physical-level interactions (for instance, by adding media and characters with the mouse or keyboard; edit-

ing dialogues with a keyboard or voice recording). We were able to define custom bindings for any available feature in the platform, and for any input device we wanted to use. Likewise, Lepi supported interchangeable graphical (image and video), textual, and aural output to convey information.

As our intended audience had fine motor skills, the participants used the mouse and keyboard to provide input (Figure 3d). The strategies to map abstract commands into the input devices varied in accordance with the interaction needs of the participants. For instance, although some participants could not read nor write, they were able to listen, speak, and draw. To overcome the writing barrier, we decided to provide editing alternatives in Lepi or exploit the working model for collaboration – in a similar way to the scaffolding practices which have been previously employed in technologically-enhanced learning environments [25, 50, 53]. This resulted in independent and assisted approaches for game creation. In the independent approach, a Creator carried out activities on her/his own. In the assisted approach, a Collaborator (acting as Enabler) helped the Creator to carry out her/his activities. The Collaborator acted as a form of human-powered assistive technology, by extending the Creator's abilities with her/his own to overcome interaction barriers (Figure 3f). The Collaborator also acted as an interaction interpreter and/or mediator. For input, she/he translated commands from the Creator to the system. For output, she/he transformed content information from the System to the Creator.

By adopting content creation approaches, the participants could make a contribution that was based on their own abilities and skills. The strategies that involved producing a first prototype in The Conversion phase: (i) typing stories and exploring the visual programming language offered by Lepi. This was the strategy of choice for participants who had previous experience with computers and could write well. (ii) Creating low-fidelity prototypes with paper and pencil containing drawings, sketches, graph-based schemes, or comic books. These were strategies adopted by participants who preferred to communicate visually. The participants who could write annotated their illustrations. Those who could not write dictated the content to Collaborators. (iii) Creating low-fidelity prototypes via speaking, with voice recordings or transcription. The participants who did not like to draw or preferred speaking, followed this strategy. The collaborators transcribed the text for the participants who could not write.

After Conversion, the healthcare professionals (Supervisors) performed the Evaluation phase to analyze the projects. They advised the Creators on how best to proceed to achieve a successful rehabilitation. For instance, they asked questions to prompt reflections, requested descriptions of past experiences, provided alternative scenarios for thinking, and asked the Creators to explain the reasoning and rationale behind their story branches and their impact on the Player's score. Game-wise, the Creators responded to the content-related requests during the Creation phase. In the case of the most independent participants, the Conversion and Creation phases were similar; they used Lepi to create high-fidelity game prototypes. With regard to the assisted participants, the strategies employed for implementing a high-fidelity prototype varied according to their

preferences. The Creators used the visual constructs of Lepi for characters, environments, scenes and story flows (transitions and branches), and decisions (choices and consequences). The Creators defined their stories by typing them, recording a voice-over narration, or asked a Collaborator to type it for them. To each according to their abilities.

After iterations of Creation and Evaluation phases, the participants played games with each other in the Distribution and Use phases. They could also play games created by the Collaborators (for instance, Collaborators with a nursing background created several games involving drug and alcohol usage in daily activities.), which showcased more Lepi features. Following this process during several meetings, some participants who had initially, adopted the assisted approach, started using Lepi on their own (in some cases, Collaborators transcribed narrations or dictated characters, to allow the Creators to type their stories). The participants who were initially given assistance the whole time, started becoming more independent (their games became longer, more complex, and relied on more features and resources provided by Lepi). Overall, the participants stated that they enjoyed the creative activities ("*creating is very good. It is the experience of my own life*"; "*it is, a new experience, a good experience*"); it was something that they looked forward to doing at the service ("*I don't mind missing the lunch, I want to create my game*"; "*I count the time when I can go to the workshop*").

3.3 Making Creation Easier, Enhancing Play: An Accessible Platform for Creators, Accessible Games for Players

We tweaked Lepi every meeting with new features, improvements in accessibility and usability to cater interaction needs of the participants. The changes to improving accessibility and usability included the following: alternative color schemes (from darker to lighter); increased contrast; larger font sizes; typefaces with better readability; short and objective text instructions (whenever possible); large graphical icons; voice instructions. For input, we avoided difficult interactions (such as holding to drag), and offered large areas for selection. As people with drug addiction may have difficulty in concentrating [49], we also tried to provide automated input features whenever applicable (for instance, for audio scene playback) to avoid errors and minimize user input (by reducing the chance of mistakes). We tried to keep activities flowing continuously, by avoiding idle intervals, dispersion, and errors, to help concentration. The Supervisors and Collaborators were always present and the Creators could request assistance whenever needed.

The resulting games had to be accessible as well, because the Players' abilities could be different from those of the Creators. This was addressed with the architecture: it was possible to change IO interactions of the resulting games during the Distribution phase to suit the Players' needs in the Use phase. Default assets provided images, textual description, speech narrative, and sign language videos as output alternatives. With regard to content that was Creator-made, the participants had to define and include their own alternatives. With the aid of

the working model, Creators and Collaborators could provide alternatives based on their abilities and skills. In the Enrichment phase of the working model, a Supervisor requests the Collaborators to refine the game assets and usability, or provide accessibility features and alternatives for use.

At the CAPS/AD, the Creators told their stories using text, speech, and drawings. In Lepi, the stories were often created as text; this meant that the participants who were unable to read, could not play unassisted ("*Can you read this for me?*"; "*What is she saying?*"). This was a concern for the participants in Goal 1.4 and Goal 1.5: the main requirement was to make independent play possible for the participants who could not read with the voice content. Between the meetings, the Collaborators acted as Enablers to record text into voice. After the content had been added to a project, the Players who were able to hear it, could play it. Although these were external contributions, Creators greatly appreciated being included, because it meant they improved their projects. Furthermore, it enhanced the playing experience, and also allowed their friends to play. Some participants noted that they could record their voices and include the recording in their future games to postpone the experience and enable their friends to play. As one of our Collaborators knew basic Língua Brasileira de Sinais (LIBRAS), some games offered sign language videos to enable people with hearing disabilities to play them. Although the participants did not need them, they thought that the videos were important.

Furthermore, in practice, following an assisted approach, a Collaborator can act as an Enabler during the Use phase to translate any content to those who cannot perceive it[2]. In particular, the roles in the working model are transient, and participants can make a contribution on the basis of their skills and abilities, as well as the context of use. Thus, whenever the activity occurs in a shared environment (such as this service or a classroom), a Creator can become a Collaborator and provide assistance. For example, a Supervisor requested that one Creator should read his story to help his friend who could not read (Figure 3b). This Creator, thus, became a Collaborator (Enabler) at that point, since he was able to assist his friend. He provided a skill (reading) that was necessary to overcome the accessibility barrier, by exploiting another ability that he possessed (speaking) and one that his friend had (listening). At other meetings, the participants who were acting as the Players employed this strategy during the Use phases whenever an audio transcription of the story had not yet been added to the project.

3.4 Being Part of the Game: Creators within the Creation

In the first meeting, one participant (hereafter called P_1) wanted his "*game character to be inside the game*"; it "*should look like me and walk like me!*" (Goal 1.6). In response to the request, a Collaborator started designing a game model representing P_1, which became available at the fifth meeting. On one

[2] In the case of motor disabilities, a Collaborator could also help a Player to play (for instance, with automation features or assistive technologies).

occasion, a friend (P_2) saw the model. He promptly (and happily) identified P_1 ("*Look, it is P_1!*"), and requested a character to represent himself as well. When he had both models, P_2 realized that he and his friends could become his stories' characters. He further requested the CAPS/AD as an environment (a place) (Goal 1.7), to share stories about users and the activities that were carried out in the service. P_2 also discovered that he could give a "*voice to my characters to help my friends to play my game*".

Being in a "magic circle" can serve as a metaphor for game playing [19]. P_2 became a Creator of his own "magic circles". Other participants joined him, and requested their models as well (Figure 2a). A healthcare professional and a participant co-created a game to promote the service (Goal 1.9): they described how it worked (by trying to demystify the public opinion about it), and explained that users were well received and benefited from it (Figure 2c and Figure 2d).

3.5 Self-Improvement Through Games: Self-Expression Leading to Self-Knowledge

In the first meeting, we encouraged participants to create games based on their experiences with alcohol and drug abuse using fictitious characters. During the meetings, healthcare professionals suggested that the participants could explore any other themes that they wanted as well. In both cases, there were participants who decided to portray themselves in the stories, instead of fictitious characters, for self-expression ("*I will do this story for myself, because I want to live this moment, show that I can do it. I am able, because no one is born knowing*"). This became more apparent once they could include their own images and the environment of the service into their games. One healthcare professional stated that most of the participants' stories were (directly or indirectly) related to their own lives, regardless of the subject.

The participants who portrayed themselves in alcohol and drug related stories admitted their own addiction and abuse in their creations; they were honest about the facts (for instance, how they happened, what they had done, when something happened, and whom they were with). Moreover, the stories acted as a support for therapeutic practices. The Professionals could analyze them and help participants, by suggesting different ways of addressing situations (for example, other ways to act) from the decisions made in the stories. During the Evaluation phases, the healthcare professionals started broadening the scope of their advice, by suggesting that the Creators should consider alternative scenarios and ways of coping with a given situation. By analyzing their past experiences and reflecting on them, the participants could find other ways of acting in their original scenario, each of which could lead to different outcomes. This helped the participants "to think more about life". These kinds of reflections and lessons learned shaped their game stories. They started in a linear way, on the basis of their memories and then progressed to branching, based on the lessons learned.

The Supervisors defined attributes (health, social relationships, and work attributes) as part of the creative practices to reinforce this learning. In the case of the Players, the scores provided the means of tracking their progress during

the play. The Creators made modifications based on their own judgement: good choices increased the number of attributes, while bad choices reduced them. With the aid of multiple choices, the Creators could compare prompts and outcomes to see how far they could affect their own lives. From the standpoint of the Creators, they provided another way of showing and applying what they were learning in the service, as well as sharing this knowledge with others ("*if you add what you are experiencing in the game, you can go much much further than you think*"). This helped to materialize abstract ideas into concrete, quantifiable outcomes based on decisions and their results, with could foster reflection during the creation and play (Goal 1.8). The participants applied the knowledge provided by the professionals in practice, even if they were unaware of it.

The games were a self-expression of what the participants experienced (or imagined) and analyzed, expressed digitally as game features (Goal 1.11). Their prompts for decisions had consequences that they could foresee and judge according to the parameters. From the standpoint of Computer Science, the sole objective of the framework was creation and playing. However, when used for serious activities, the games became means rather than ends. More significant results can emerge from enabling participants to make something and collaborate. Like play [2, 31, 44], creation can have a therapeutic value in themselves, as, according to one participant, "*creation occupies the mind with fun. I avoid thinking bad things*". The participants could share values and teach others (Goal 1.10). Their games could help others ("*people will learn a lot from my game, they can start thinking that they can re-start their lives if they believe in it*"), and could also help themselves ("*creation helps to find paths, and weigh up the consequences of each*"; "*creating games is great for participation and learning*"). The Creators could "*recount experiences, learn good things, always move forward, and interact with friends*". Players could learn that "*in any path, there is always a better exit*".

3.6 Sharing Knowledge: Learning and Experiencing from Playing

In the working model, the Supervisor decides who can play a game, as well as defines available interaction features for the Players. The architecture combines these features to generate playable games that are compatible with a Player's abilities and skills. In the first meeting, P_1 mentioned that game creating and playing could be good for his own therapeutic treatment and also for that of others. In the third, P_1 realized that his game could heighten awareness of the effects of drugs and alcohol abuse: he could advise players to avoid abusive substances on the basis of his experience. He, thus, wished to share his game in schools, because, then, "*kids can play my game and learn from my mistakes*". In future meetings, other participants reinforced this opinion (for instance, "*people can do what I did, see what I did, what I created (...) then the person can say 'I can change, it only depends on me, we can find a way to tackle everything'*").

Initially, the participants were uncertain if they could create games; some of them had not even played digital games (or used a computer) before. During the meetings, they became more confident, skilled, and proud. In their games, the

Creators expressed how they could overcome their doubts, insecurities, and fears. They could track how their games evolved and hence measure their progress: each new scene and added feature showed this evolving pattern. As well as what they achieved in their game, the participants also progressed therapeutically, owing to their service support ("*when I started, I wanted to learn many things, but I see that I have learned a lot already*"). The Players could also learn from the experiences of others (Goal 1.13). Games were a safe environment: the negative outcomes from bad choices provided feedback for learning (Goal 1.14). In the end, once the projects were completed, participants shared their games (Goal 1.16). They started teaching their peers how to play their own games, and took pride in it (Goal 1.12): "*knowing that someone will play my game is very good*"; "*it is great fun to show people my game; you keep thinking 'how is it possible to create a game and see your friends playing it?*".

Interactions between Creators and Players during the Use phase (such as playtesting) were helpful for the participants in three different ways. First, the Creators adopted a new attitude when showing their games to their Player peers (for instance, a participant who was initially scared to use the mouse taught a friend to use it when interacting with her game). Second, the Creators felt proud at seeing their games in use ("*seeing my friends playing, for me, is an honour, because I can share the game with them here to see that they care about me*"). Third, the games can serve as tools to assist Supervisors in their professional practices. For instance, a Supervisor requested that a Creator explained his rationale for assigning scores to his peers during the game. On the basis of his explanation, the Creator, Players and the Supervisor discussed the game (Goal 1.15) and shared similar experiences Goal 1.17. The Supervisor advised a large number of participants at the same time; the Creator reflected on his choices and showed what he had learned; and the Players received and provided assistance: learned from the Creator's game and from the Supervisor, and helped the Creator by describing similar real world situations that had happened to them.

3.7 The Way Games Can Transform Participants: Anecdotes

Previous sections can be illustrated by sharing the reactions of one participant (P_2) in a meeting, whose experiences motivated another (P_3) to further participate (Figure 3a, Figure 3b). In the Use phase, a Supervisor asked P_2 to explain his game to the public (Goal 1.11, Goal 1.15, Goal 1.17). As there were participants who could not read, she requested P_2 to read his story aloud (Goal 1.5). At first, P_2 was nervous and insecure about the value of his creation ("*I don't know...*", "*I am not sure...*"). However, as he proceeded to read his story and answer questions, he became more confident. His attitude improved and he started to smile and laugh; at a certain point, his eyes started glowing. As a result of peer acceptance (Goal 1.12), he was proud and pleased with his creation, because it was successful (Goal 1.1; Figure 3b). When the Collaborators showed the enhanced version of his game, P_2 became enthusiastic about the changes, as they improved its quality and allowed his friends to play the game without his

help (Goal 1.3, Goal 1.5). The enhanced version enabled P_3 to play. She shared her experiences (Goal 1.17), providing her own insights and personal response to his story. P_2 and the Supervisor appreciated her insights (Goal 1.8, Goal 1.13). Her comments showed admiration and appreciation for P_2, who asked if he could present his game to the community in an upcoming soirée at the CAPS/AD. In the case of the Supervisor, it offered new information regarding P_3, which she could make use of to help the participant further.

After this experience, P_3 became motivated to create her own games in the following meetings (she had not participated in creation activities before). P_3 had never been to school, nor used computers; he was one of the participants who had been scared of using computers and touching a mouse. P_3 saw P_1's and P_2's models, and requested her own (Goal 1.6). As the meetings progressed, she started using a keyboard (Goal 1.2) to create her own game (Goal 1.3): she narrated her story to a Collaborator, who transcribed it, and, later, dictated the characters to P_3. Sometimes, she narrated her stories with her own voice (Goal 1.11). P_3 included herself, her friends, and the CAPS/AD's environment in her stories (Goal 1.7; Figure 2a and Figure 2b). As a Creator, she advised her friends how to make better decisions in her stories (Goal 1.10, Goal 1.17), in the same way that her Supervisor had advised herself (Goal 1.15). She wanted her children to be proud and motivated by her games ("*I want my kids to [play my game and] think, 'wait a second; my mother is making games, I can also do it'. It is very beautiful*"). As a Player, she always chose the best options when prompted to make decisions; she also played her own games several times (Goal 1.13, Goal 1.8). P_3 spoke about her games to her daughter, who could not believe her: "*my daughter thought I was lying when I told her I created a game*". At a later meeting, when the healthcare professionals invited other users to play the games (Goal 1.16), P_3 started teaching others (including her boyfriend) to play her game (Goal 1.4). From being scared of using computers, she reached the point of teaching other people how to use them.

Finally, with her own character, P_3's model became an asset for creation (Figure 3d). In P_3's stories, her model was always herself ("*I wanted to put myself in the game to show that I could do it, I can be there, I can be anywhere, I can think about what I should do, what I should not do*"). In stories from others, her model was someone else (with different names). Although it was her own image, it was not her. Whenever she saw her image, she asked: "*is this me?*" She was an actress. She felt important for a day (Goal 1.12). She (and other participants) had succeeded (Goal 1.1). Even though she had "*never imagined I would be able to do it*", she found that she was able to do it, could further improve ("*you can create lots of things there to show people*"), and had opportunities for social inclusion ("*I had never had as many opportunities as this in my life*"). This feeling was shared by the other participants, "*I could never imagine something like that could come out of my head*"), as well as by a healthcare professional who stated the following: creation together with therapeutic activities "*enabled patients to have contact with technology, develop their cognitive skills and creativity, encourage game creation, [self-]identify with the activity, and provide opportunities to think*

about real or imaginary situations. This allowed them to learn behaviors to deal with daily situations of conflict [in real life], acquire self-esteem during [the act of] creation, and teach patients that they are responsible for their choices and [their] consequences".

4 Design Recommendations from Lessons Learned

The following design recommendations summarize the strategies described in Section 2 as being necessary to achieve Table 1's goals:

1. **Design for semantics of use**. If semantics of use are designed, we do not assume any abilities are required for use, and, thus, people are not excluded by design.
2. **Implement for modification**. We can re-shape human-computer interaction at-use time to enable people to perceive, understand and command digital games according to their needs and abilities.
3. **Provide different ways to create and play**. Digital inclusion does not have to imply "one-size fits all solutions"; rather, a game may have the same rules, but can be played differently (for instance, there are multiple accessible versions in one game).
4. **Compose interaction**. We can provide interaction alternatives and (re-)combine them to define custom user interfaces that can enable interaction. We can group alternatives into profiles aimed at particular interaction needs (for instance, for visual or hearing or motor disabilities) – or allow people to define their own.
5. **Focus on abilities and skills**. People can always make a contribution on the basis of their own strengths (abilities, skills, knowledge, interests, experience). Therefore, one important goal for co-creation is to identify and provide opportunities for people to make contributions.
6. **Foster community inclusion**. Accessibility to inclusion can be an iterative process, based on abilities.
7. **Consider inclusion as a dynamic process**. Once people are included and able to create, they can enable more people to use the system and/or create. In particular, people with disabilities can become contributors once they have been included.
8. **Foster community collaboration**. People can teach, learn and benefit from each other's strengths, and understand how they can achieve more as a community, than individually. This workflow benefits both the sharer and receiver: they may feel empowered, important and valued, as well as creating bonds with each other. In serious contexts, domain experts can further benefit from communal collaboration and discussions and, thus, provide advice, guidance, and feedback to their participants.

5 Concluding Remarks

Although there are a number of approaches that can enable people to create their own digital games, their intended audience is, currently, narrow; enabling people

to play and create are important stages in achieving digital and social inclusion. In this paper, we have examined our experiences in establishing a framework that can enable more people to create and play digital games. Co-creation was supported by a framework for game accessibility moving towards accessibility modding. By combining an architecture, a collaborative working model, and a game creation platform that could suit the interaction needs of the participants, the framework enabled participants to co-create games. The architecture allowed us to build creation tools and games able to modify IO interactions arbitrarily, at use-time. With the aid of the model, we were able to guide end-users to create games collaboratively, with the prospect of learning from (non-computing) domain experts in the process. The game creation platform helped the participants to create and share their own games.

In this study, it was found that the framework promoted inclusive game creation for an initial audience. We have explored inclusive game co-creation in an attempt to support therapeutic practices (that involve assisted self-improvement) by adults with low levels of literacy in a drug and alcohol abuse rehabilitation program. The outcomes from several workshops were analyzed to demonstrate how the framework supported the participants' self-improvement. It was found that game co-creation promoted self-expression and self-improvement. The participants took part in creative projects to teach and share what they knew, received guidance and support from healthcare professionals, and played games so that they could gain experience and learn from others.

Instead of an end in itself, game creation became a journey, in which the participants acquired and shared knowledge and skills, while crafting a game in the process. They learned and showed that they were capable of improving themselves, by creating, sharing and teaching. If they had any doubts, the Supervisors were there to support them. The game was the artifact, their way of expression, and their gift to others. It started from acceptance, believing in oneself and that one would be able to do it. Next, in working towards this end, iterating to improving the creation, and continuously observing the progress made towards its completion. Thus, what the Creators achieved was self-improvement, more self-confidence and hope, and the recognition that they are able to do whatever they put an effort into, even if it seemed impossible at first.

Establishing a framework is a step towards enabling more people to create and play digital games. We are currently working with new audiences (for instance, people with visual and motor disabilities as creators and players with text-to-speech and voice input for simple commands) and mechanics, as well as setting out new goals (for instance, digital co-creation as therapy).

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