Strategies for Inclusive End-User Co-Creation of Inclusive Storytelling Games

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Abstract. As gaming acquires new purposes (for instance, entertainment, education and healthcare), game accessibility becomes increasingly important for multiple domains. For broader inclusion, game accessibility encompass both creation and play. Towards this goal, we have defined a framework to enable more people to create and play digital games In this paper, we present strategies resulting from developing and evaluating Lepi, an inclusive end-user tool for co-creation of inclusive storytelling-based games. Adults with heterogeneous interaction needs, levels of literacy and experience with computers used Lepi to co-create their games over ten creation workshops. Using Lepi and following the framework practices, the participants managed to co-create games accessible for themselves and their peers. From this experience, we have identified some strategies (Creation Commands, Interaction Alternatives for Input, Slots, Creation Alternatives, Assisted and Collaborative Co-Creation, Gentle Slopes, Multimodal Features, Playing Commands and Presenting Game Content) which can contribute towards more inclusive practices of game creation and play of storytelling-based games.

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

1 Introduction

Game accessibility aims to enable more people to play digital games. Although the Literature provides techniques, guidelines, and strategies (for instance, in [9, 12, 15, 16, 29]), developers often ignore game accessibility recommendations, for reasons including efforts (for instance, costs and time), impossibility of application and unfamiliarity [1, 23, 28]. Developers often makes assumptions of user abilities [24], which, in practice, do not always hold true. As a result, people whose abilities were not considered during design might become unable to play.

As gaming expands to new applications and domains, accessibility issues may hinder digital and social inclusion. Besides the traditional entertainment value,

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domain experts can explore digital games as tools to support their activities. Education and healthcare are two examples of serious domains that have been exploring games to enhance learning, training, therapy and rehabilitation practices [8, 13]. In these domains, experts can use games to aid people with heterogeneous characteristics, including age, socioeconomic status, (dis)abilities, skills, interests and knowledge. With such heterogeneity, assumptions of abilities and skills can limit audiences for games in serious domains. However, the people in these domains often possess the knowledge and skills required for inclusion that the original developers lacked. In education, professors and special educators can remove communication barriers for students. In healthcare, therapists can support use without harming their patients. Moreover, in both cases, students and patients could further provide their skills to enable use.

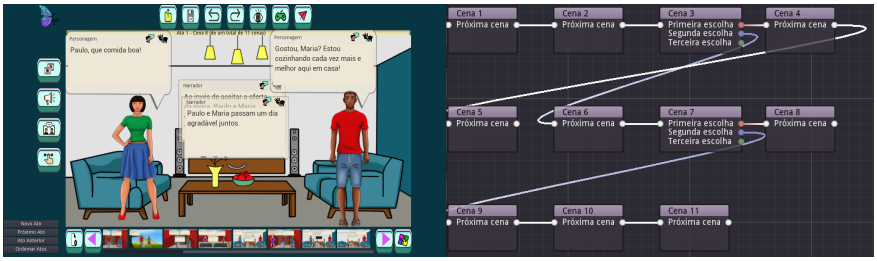
In this scenario, co-creation could provide a different strategy to promote inclusion. To achieve a scenario on which end-users could co-create inclusion, they would have to act as non-professional software developers to improve the original game. Game modification (popularized as "modding") [13] is a popular term to describe End-User Development (EUD) [18] practices in games. EUD provides methods, techniques, and tools to allow end-users to create, modify, or extend software [18]. Game creation and modding expand these practices to game making.

Although, traditionally, EUD is concerned with functional software features, it may be employed to improving non-functional features. In particular, EUD could contribute to co-creation of accessibility and usability, which we have been exploring by the means of a framework to promote inclusive co-creation of inclusive games [10, 11]. With the framework, we can implement software without assuming particular interactions, enabling communities of end-users to co-create alternatives to enable use and promote inclusion. This way, the community may provide broader accessibility even if the original developers failed to do so. The community, thus, practices "accessibility modding" towards broader inclusion.

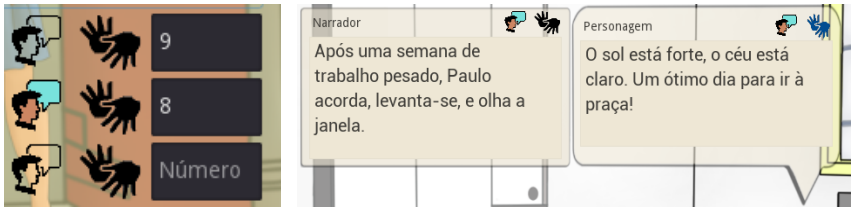
Lepi (Figure 1) was the first game creation tool developed for the framework, serving both as a proof of concept and a study of a viability. As a proof of concept, Lepi targeted a single genre (storytelling-based games) with a subset of features considering interaction needs of potential creators and players (mainstream audiences, hearing disabilities and low literacy)[1]. Participants with heterogeneous interaction needs (adults with different levels of literacy, computer skills, and emotional characteristics) used Lepi in a public healthcare service during ten collaborative workshops performed at a period of four months at an alcohol and drugs rehabilitation program[2] [11]. To enable every participant to play every game, participants collaborated to provide accessible content to the game according to their abilities and knowledge. As they were not programmers,

[1] Although some of these features can assist people with vision disabilities to play, we have not yet addressed creation for these audiences.

[2] We complied with research ethics protocols throughout the entire evaluation. Certificado de Apresentação de Apreciação Ética from Plataforma Brasil: CAAE: 89477018.5.0000.5504.



(a) Creation interface. (b) Linking scenes (graphics).



(c) Linking scenes (text). (d) Slots for text, audio, and sign language video.

Fig. 1: Lepi provides interfaces to suit different interactions needs.

we explored an iterative and incremental process to adapt Lepi to suit and support the participants' interaction needs for use and co-creation. In this paper, we have generalized adaptations and features that we have explored into strategies that we had followed to enable the creation and workflow, promoting inclusive end-user co-creating of inclusive storytelling games.

2 Related Work

2.1 Game Accessibility Strategies

Although enabling end-users to create inclusive game is an incipient practice (for instance, there are solutions to support the development of memory games by blind users under supervision [14] and to form communities of audio game designers [27]), existing studies regarding game accessibility seem to be aimed at professionals developers. For instance, Universally Accessible Games (UA-Games) have techniques to support professionals designing [15, 16], and implementing them [9, 12].

Another useful artifact for developers is the game interaction model from [29]. The model defines a finite state machine based on how players interact with a game during play. A player cycles among three states ("receive stimuli", "determine response", and "provide input") to play. Based on the model, high-level strategies for game accessibility include: enhancing stimuli and replacing stimuli (for the state receive stimuli); reduce stimuli, reduce time constraints and

reduce input (for the state determine response); reduce input and replace input (for the state provide input). We have explored these strategies to define the framework's software architecture, as well as to provide interaction alternatives for creation tools and generated games.

2.2 Collaboration and Accessibility

Communities are an important element for game modding [5]. In this paper, in particular, we explore communities as receivers and providers of inclusion. This is similar, for instance, to "communistic interactions" ("from each according to their abilities, to each according to their needs") [19] and to accessibility as interdependence [3]. For the former, inclusion should aim for groups of people instead of individuals, and on abilities instead of disabilities. For the latter, interdependence can highlight relations and dependencies between people and things.

We argue that, from a combination of both (individuals and groups, independence and interdependence), communities could start providing and receive support to enable game creation and play by more audiences. To achieve this result, communities would need computational support to co-create.

2.3 Storytelling in Game Creation and Modding

Storytelling has been previously explored to promote game creation by end-users. For instance, ScriptEase [6] is a tool to convert text into game scripts for Neverwinter Nights. <e-Game Project> [7] (aimed at writers) describes a documental approach employing a Domain Specific Language (DSL) to create graphical adventure games. Writing Environment for Education Video Games [20] (aimed at educators) provides a methodology for the creation of stories in point-and-click games. As with <e-Game Project>, it also employs a DSL to promote content creation.

However, to the best of our knowledge, intended audiences for existing solutions are literate people. In this paper, we aimed at broader inclusion to support people with low literacy as well other interaction needs (for instance, providing signs for hearing disabilities and audio-description for visual disabilities). We explored for in-game adaptation (created by the end-user acting as non-professional designers/developers) supported by the creation tool (Lepi) itself. This contrasts to current approaches in two ways, which may enable more inclusive creation and result into better quality and experience of use. First, the tool provides features for adaptation (later discussed in Section 4 and Section 5) to tailor generated games to players during use, potentially enabling new audiences to play. Accessibility features are typically are not available in creation tools [1]), forcing players to resort to external tools (for instance, assistive technologies) which were not considered during design, resulting into low quality of interaction and use [1, 29]). Second, creating the tool with the features them allows for defining different ways to promote game creation, potentially enabling new audiences to create. To support this workflow, we fostered community collaborations.

3 Research Approach

This paper results from lessons learned from past studies regarding game design and implementation for game accessibility (visual, hearing, motor and cognitive disabilities), and serious games education and healthcare (depression, and alcohol and drugs rehabilitation) [8, 9, 11, 12, 26]. We adopted Participatory Design [22] and Organizational Semiotics [4] as research frameworks for design activities, gathering requirements from participatory workshops performed at public schools, hospitals and healthcare services. For use (design and play), we started the research gathering requirements for designing and implementing serious games for these institutions [8, 26]. For implementation, we had defined approaches to improve game accessibility [12] based on recommendations from the Literature, which resulted into a game engine [9]. The game engine was simplified to its core architecture [10], which we briefly outline in Section 4.

Over time, we have progressed towards end-user co-creation of digital games [10, 11]. In our considered domains (students, patients, and educational and healthcare professionals), we found storytelling as a suitable introduction to end-user game creation via visual novels[3]. Lepi was developed to assist inclusive end-user co-creation of inclusive storytelling games. It was designed and initially implemented based on our previous experience, and improved in an incremental and iterative process in participatory activities as research participants created games with it.

Design considerations and evaluation are detailed in [11]. As anticipated in Section 1, we have performed co-creation workshops in ten activities over four months. In the workshops, participants co-created their games using Lepi according to their own abilities and preferences. For instance, participants able to write and who had previous experience with computers opted to type their stories. Participants unable to write either recorded their story in audio (then inserted the resulting file into the audio slots of Lepi) or dictated their stories to Collaborators, who either typed the content for them or spelled the characters to the Creators. Likewise, some participants opted to draw or sketch their stories before inserting them into Lepi. Others opted to use Lepi directly (especially on their following creations).

To enable every participant to play every game, Collaborators enhanced the projects with complementary content to fill the other slots in Lepi (performing the proposed "accessibility modding"). This included, for instance, voice content for written stories and text content for voiced stories. Therefore, they co-created inclusion together, as a community, based on the skills and abilities of each member. Similarly to the creation, every participant could play the resulting games based on their interaction needs and/or preferences. Without the collaborative enhancements, this would have been impossible: for instance, people unable to read would not be able to play text-only stories. In the remainder of this paper,

[3] Reasons included: focus on story over programming; closeness to traditional media (for instance, books and films); potential for introducing programming practices over time [11].

we described the strategies that we have explored to support broader inclusion for creation and play.

4 An Inclusive End-User Development Framework for Tailorable Games

To enable more people to create and play games, we have designed a framework to foster community co-creation of inclusion games [10]. The framework defines (i) a software architecture for game implementation, (ii) a collaborative working model to support co-creation and (iii) game creation approaches to enable end-users to develop their games.

Based on the concept of tailoring [21] (adaptations of software to suit the practices of a user), games implementing the architecture were named "tailorable games". The central idea of the architecture was allowing the implementation of interaction-abstract games, defining commands and semantics of use instead of pre-defined interactions to enable play. This way, developers can define interaction alternatives to suit different abilities and skills from players iteratively, one audience at a time, via "interaction add-ons". These add-ons can be attached to (or removed from) a game, defining how a player sensory perceives the game (for the "receive stimuli" phase of game interaction model from [29]) and controls it (for the "provide input" phase of the game interaction model).

To foster community co-creation, we have defined a collaborative working model around the flexibility of the architecture. The central idea of the model was enabling members of a community to provide accessibility features to a game project. In the same way modding enables a community to improve aesthetics, content and gameplay for games, the collaborative working model promotes "accessibility modding" towards broader inclusion. As with "communistic interactions", members of a community can provide their own abilities and skills to create (or improve) accessibility features (interaction alternatives) to enable new audiences to play. In particular, if these people had support to co-create the game, they could further contribute to improve it. Their own abilities and skills could, potentially, include other new audiences, defining "cycles of inclusion". This way, inclusion could become an iterative and dynamic process, because people who become able to play may further contribute to improve the game.

As end-users are (usually) not programmers, game creation approaches enable and support the co-creation. In special, systems for co-creation can also implement the architecture (for the same benefits) to become tailorable systems *and* implement tailorable games as their projects. From this, it results inclusive end-user creation tools able to define inclusive games – that is, game making tools as well as games that members of a community can improve with content, accessibility and usability features to promote play and inclusion. Lepi was the first tool that we have defined to explore this idea.

4.1 Strategies of the Framework to Foster Inclusion

Decoupled Interaction from Logic. The architecture simplifies the engine from [9, 12] to a few elements – components, entities and subsystems from Entity-Component-Systems (ECS) events and event handlers from Event-Driven Architectures. These elements, combined, allow for modifying game interaction at use-time (run-time). These elements allow developers to change input and output (IO) features of an entity at run-time [9, 12], as they can make arbitrary interaction toggle-able. For instance, entities with graphical components are graphically represented into a screen. Once the component is removed, the entity stops being represented (although it still exists). This idea allows swapping ways to control (input to command) and represent (output to convey) an entity, even when the game is already running. For accessibility, particularly useful applications of EDA include providing immediate feedback to players (for instance, with sound, haptic, or graphical effects) and implement game agents able to provide input to the game.

Interaction-Abstract Implementation. To achieve interaction-abstract digital games using the architecture, the implementation should not impose any fixed physical-level IO-related interactions for use. Rather, the architecture proposes that developers define semantics of use (that is, define *what* the play can do) first, then provide interaction alternatives (that is, define *how* the player will do it) to allow users to apply the semantic to play. This allows developers to implement interactive systems without assumptions of how a player will use it to, and to interaction alternatives to define physical-level interactions. This way, developers can re-define the "receive stimuli" and "provide input" states from the game interaction model at use-time.

Commands. In the architecture, commands abstract the proposed semantics of use. They are implemented as events. Commands define possible actions to express intents of what a user wants to accomplish when using the system. Commands are usually verbs expressing actions available to modify the current state of the system. For instance, in a storytelling game, commands can include "choose an option", "confirm / cancel a choice", "forward / rewind a piece of dialogue". The implementation processes these commands; as they are events, an interaction-abstract implementation reacts to them whenever they are issued. In turn, the system performs the required processing to change its internal state. This makes it easier to implement interaction alternatives for input, input (re-)mapping [17] and provide automation features. For the latter, the system can dispatch a command to provide input on behalf of a player, assisting players who may need help at the "determine response" and "provide input" states of the game interaction model.

Interaction Alternatives for Input. For human-interaction, developers can offer multiple implementations of physical-level interactions to map users' abilities into commands to allow for user input. Thus, instead of single, fixed and predefined mappings, developers can provide users with choice. If a pair consisting of an input device (for instance, controllers, mice, keyboard, microphones, cameras) and mechanism (for instance, button presses, stick movements, spoken

words, gestures) can be translated into a command, then the pair can be used to control the game. These pairings can be defined via input (re-)mapping (for instance, "press ENTER" or "say CONFIRM" perform the command "confirm a choice").

Interaction Alternatives for Output. As the design should not impose any physical-level IO-related interactions, the concepts of sign and signifier from Semiotics [4] are useful for the architecture. These concepts enable separating a message (abstract meanings, conceptions and functions for things in signs) from its representation (denotation using symbols through signifiers). If game output is considered as the means to continuously providing message to translate the current state of the abstract simulation (a sign derived from data) into concrete representation (signifiers representing information) to a player, then providing accessible stimuli becomes the task of matching signs to accessible signifiers. As a result, the final user interface can be a composition of output alternatives to convey the internal state of the game to the player. This allows modifying game presentation to support the "receive stimuli" state of the game interaction model.

5 Strategies for Inclusive End-User Co-Creation of Inclusive Storytelling Games Defined in Lepi

The strategies from Section 4.1 were applied to the iterative development of Lepi over the workshops to enable our initial audiences (including people with hearing disabilities and low literacy) to create and play storytelling-based games. In this section, we describe how we abstracted from the end-users acting as creators and players.

5.1 Strategies to Enable Inclusive Creation of Storytelling Games

Creation Commands and Interaction Alternatives for Input. Lepi, as an editor, provides commands underlying user interfaces and widgets to perform the processing (for instance, "add / edit / remove an entity", "add / edit / remove a piece of dialogue" and "add / edit / remove a new scene"). Creation commands can be bound to available input devices to enable use. The architecture idea of interaction add-ons enable combinations of commands to define macros, which Creators can attach to their software to perform compound commands.

Slots. In storytelling games, entities can be characters, places and objects as well as pieces of dialogues and narrations. In Lepi, every game entity can be multimodal. To support the current audiences, entities have text, image, audio and video slots. To abstract the architecture from the Creators, Lepi provides slots to represent different signifiers of a same sign. Creators can attach data and media files into these slots to convey a very same sign in different ways. For instance, entities support text, audio, image and sign language (video) descriptions. Likewise, text, voice audio or sign language video can convey dialogues

(Figure 1d). Once a Creator fills a slot providing its media, the content can be reproduced to players to sensory convey the desired information.

Creation Alternatives. Slots featuring multimodal alternatives mean that people with different knowledge, skills, abilities and background can contribute with the development of the project. Thus, people have opportunities to co-create based on their preferences and skills, instead of being unable to contribute based on what they cannot do. For instance, the current slots enable people to collaborate based on writing, speaking, drawing and acting skills. Thus, besides the traditional text composition in storytelling games, Creators can provide content to Lepi by adding voice narrations, drawings, and sign language videos into their slots. Initial prototypes can start with low-level technology (for instance, paper) to explore ideas (such as a sketch of the story in a comic book format). Once the idea is refined, creators can insert their content into Lepi.

Assisted and Collaborative Co-Creation. Although independence is often strove in accessibility [3], people can assist one another to co-create. Their abilities can complement each other to overcome barriers that each one could not address individually ("cross-ability cooperation" [3]). In the collaborative work model, Collaborators provide these external assistance whenever Creators cannot satisfy their own abilities – or those from their Players – alone. Collaborators can create and provide accessible media, add support for assistive technologies or even support use (for instance, a therapist can help a patient to perform tasks that he/she would not be able to do on her/his own). Every collaboration contributes to broader inclusion. For creation activities in serious contexts, there will often be people who have skills and knowledge to contribute towards inclusion (for instance, with audio-description or sign language content in inclusive education).

Gentle Slopes. Making syntactic errors hard (preferably impossible) and supporting incremental development are desirable features of EUD tools [25]. Practices can also scaffold creation. Creation practices should aim for gentle slopes [2], gently introducing complexity over time. Lepi explores gentle slopes within storytelling activities: Creators can start with small, linear stories and explore more complex features (for instance, branches and decisions for branching storytelling) over time. With slots, this same reasoning applies to media.

Multimodal Features. Inclusive creation requires multimodal features. Although visual programming languages and approaches are commonly explored in EUD tools (because they accessible for sighted users), they are not accessible for everyone. Rather, constructs should be multimodal. For instance, instance, in Lepi, Creators can define story branches and decisions with visual (linking connectors in a graph; Figure 1b) and text constructs (providing the next scene number; Figure 1c). For content creation, slots allow Creators to co-create according to their needs and skills (written, spoken and acted content, for instance).

5.2 Strategies to Enable Inclusive Play of Storytelling Games

Playing Commands. As Players' interaction needs can differ from Creator's, the resulting games should be IO flexible as well. The first strategy is similar to

"Creation Commands and Interaction Alternatives for Input" in Lepi. Players should be able to use their preferred devices to play the game. In this first prototype, Lepi supports traditional game input devices (keyboard, mice and controllers).

Presenting Game Content. The second strategy results from the Slots. Players can choose what slots they want to build the user interface of their games (text, image, audio and video slots). If a combination of available content is slots fulfill the interaction needs of a Player, she/he can play the game.

As, at this time, the interaction alternatives do not conflict with each other, a resulting game can have any combination of slots. For instance, one Player may interact with a traditional storytelling game, composed of text and graphics. Another play with graphics and sign language videos. Finally, a third Player may enable all features to read, listen and watch the game content.

6 Concluding Remarks and Current Work

As digital games are becoming increasingly important for different domains and purposes (including entertainment, education and healthcare), it becomes fundamental to enable more people to create and play them. Otherwise, instead of reducing social and digital inclusion, technology would contribute to increase them and to create more barriers.

In this paper, we described some strategies that we have employed towards promoting inclusive co-creation of inclusive storytelling-based games. These strategies resulted from the development of inclusive end-user tool (Lepi) for the creation of inclusive storytelling games. We have briefly described a game framework aimed at game accessibility and its three pillars, with special focus on its software architecture and Lepi, its first co-creation tool. For these pillars, we have described the strategies that we have defined and have been exploring to enable new audiences to co-create and play digital games based on their abilities and skills. The strategies resulted from our experiences in participatory workshops involving participants with heterogeneous interaction needs making games for themselves and for their peers. They focus on the concept of tailoring to adapt software to better suit interaction needs of users – in this case, to promote more inclusive game creation and use practices.

We aim to keep improving the framework. We are currently introducing creation and play features (for instance, text-to-speech and simple voice commands) to Lepi aimed at making it more accessible for visual disabilities. Some of these features should also provide the first resources towards inclusion for motor disabilities. Once we address those, the goal is introducing new mechanics for creation and playing practices, introducing new practices and tools over time.

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