frontiers | Frontiers in Computer Science

TYPE Curriculum, Instruction, and Pedagogy
PUBLISHED 29 April 2024
DOI 10.3389/fcomp.2024.1182541

OPEN ACCESS

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RECEIVED 08 March 2023
ACCEPTED 28 February 2024
PUBLISHED 29 April 2024

CITATION
Westin T (2024) Game accessibility course design modules in higher education. *Front. Comput. Sci.* 6:1182541. doi: 10.3389/fcomp.2024.1182541

Game accessibility course design modules in higher education

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Game accessibility has evolved significantly during the last 10 years, both within the industry and in research. Further inclusion in both games and the game industry requires educational resources useful within game curricula, which has been developed by the industry, to raise awareness about design and development regarding game accessibility and related issues. The purpose of this paper is to explain how inclusive game design and game accessibility can be taught to students in higher education, for curricular design, in-between generic curricula and practice. A tentative curriculum framework (TCF) was developed by the author and a co-author, based on feedback from peers. The problem is that there is still a gap between the basic structure of the TCF and how to apply it in higher education courses. The goal with this paper is to exemplify how this can be done with a set of generalized modules with course activities based on teaching by the author for two decades, that can be implemented in higher education courses, either modified or as-is, related to the TCF. A set of example modules consisting of activities is presented that can be adapted and applied by peer educators. Future work involves transforming the modules themselves into open educational resources, organized based on the TCF. Hopefully, this can motivate peer educators to also contribute with further open educational resources in a common repository, to aid each other as a community of educators developing best practices for teaching about game accessibility in higher education.

KEYWORDS

inclusion, educational, resources, course, design, curriculum, playtest, practice

1 Introduction

Inclusive game design starts with awareness among game developers of barriers that disabled people face every day, that may also be faced by people in general in different situations. Furthermore, awareness of opportunities enabled by accessibility advances in the industry and in research studies are equally important. Also, awareness of, as well as know-how to, implement solutions are fundamental for further research and innovation. This is why teaching about game accessibility and inclusive design is important, as well as providing support for teachers in this endeavor. A challenge to raise awareness is to go from implicit knowledge forms embedded in games, or embodied in experienced game developers and disabled gamers, to explicit knowledge that can define, describe and explain (Johannesson and Perjons, 2021) core issues to students. Furthermore, going from design, to design science (Johannesson and Perjons, 2021) with explicit, documented and new accessibility design knowledge, is key to further raise awareness and advance education on the topic.

This paper continues from previous work, where the author and a co-author designed a tentative curriculum framework (TCF) for game accessibility, defined as a "modular structure that support creating and sharing educational resources, as well as for teaching and learning

about game accessibility" (Westin and Dupire, 2016a,b). The problem is that there is still a gap between the basic structure of the TCF and how to apply it in actual teaching in higher education courses. The purpose of this paper is to explain how inclusive design and game accessibility can be taught to students in higher education, building on the TCF. The goal with this paper is to present a set of generalized modules with course activities based on teaching by the author, that can be implemented in higher education courses, either modified or as-is, and related to the TCF.

The goal was initially addressed in 2018 by designing a structure for Open Educational Resources (IGDA Game Accessibility SIG, 2018). This paper does not focus on specific solutions or resources, but rather educational activities that can enable learning about current advances as they evolve. These activities are structured within modules, and each module can be used within existing courses or composed into new courses. The modules of activities in this paper can hopefully aid in designs of teaching to reach out even further to aspiring game developers and students.

This paper is organized as follows. First, an extended background presenting some related efforts in industry and academia. This is followed by a set of teaching activities based on teaching by the author, structured into course modules to provide flexibility for course designers to select what fits their courses. Finally, the modules are discussed related to related research and the goal of this paper.

2 Extended background

2.1 Related research and development

Game companies, academics, (dis)abled game developers and gamers have made efforts to improve game accessibility since the earliest days of the video games industry (e.g., Hughes, 1981). Decades later, Bierre et al. (2005) presented a paper about game accessibility as "a starting point, to both educate and start a dialog" between industry and academia, an effort that can be labeled as research in-the-wild as opposed to in-the-lab, which has been hard to achieve for game research in general, as explained by Engström (2020). Today, game accessibility has been embraced by a large part of the game industry, as seen at the Game Accessibility Conference (gaconf.com) and Game Developers Conference, GDC (gdconf.com). For instance, the GDC roundtables held by the International Game Developers Association Game Accessibility Special Interest Group (IGDA GA-SIG) from 2004 to 2013, had between 1 and 10 attendees, but from 2014 to 2018 numbers increased to about 70–80 attendees, and has continued on this level since then.

To further overcome the gap between academia and industry, raising awareness about inclusive game design and what this would mean in practice, is a central activity. This can be done for example by creating meeting spaces between the game industry and disabled people (Westin et al., 2019). Meeting spaces can be, e.g., industry workshops or a university course or seminar series.

Early efforts for learning are presented by Grammenos (2008) with the concept of" learning by dying" i.e. games that can be played by no one, or universally inaccessible games, to educate with humor and counter-example. Furthermore, Grammenos also created Universally Accessible Games, showing how to make games accessible for all (Grammenos et al., 2009).

Levy and Gandy (2019) examine what impact a minimalistic 60-min lecture about game accessibility can have on games created by students, with focus on sonification features for visual disabilities. Levy and Gandy (2019) clearly shows the feasibility and need of teaching about game accessibility.

Sousa et al. (2022) explore the pedagogical value of presenting a challenge of game accessibility to students in a two-semester project, to include people with intellectual disabilities (ID). To achieve "development of accessibility-driven skills and decreasing discriminatory beliefs toward individuals with ID" (Sousa et al., 2022, p. 18), the authors "stress the importance" of collaborations with a Non-Governmental Organization (NGO). A similar collaboration is presented in this paper as a course activity.

Theil et al. (2022) provide valuable insights about deaf-blind gamers. Research to better understand various groups of disabled gamers is especially relevant but can also be hard to achieve given their special needs but also that some groups are rare (Westin et al., 2019). Thus, the outcomes of Theil et al. (2022) and similar studies need to be spread to both aspiring and experienced game developers. Personas based on empirical data can enable further inclusion by implementation in courses and Open Educational Resources (OERs) with lower effort required for teachers, although not replacing the need for including users in user studies.

2.2 Tentative curriculum framework for game accessibility

The tentative curriculum framework (TCF) was created based on international surveys to researchers in the field (Westin and Dupire, 2016a,b). It should be used only as a guide as local educational conditions may differ. The TCF divides students into three main groups; basic levels for designers and engineers, and an advanced (e.g., master) level for both groups. Learning outcomes in the TCF are: Concepts within inclusive design and game accessibility; Needs (of different groups of disabled people); Methods (for how to design for those needs); Scope (how common different issues are); Experience (emphasizing the issues and making them personal); and Solutions (with pseudo code, ready-made solutions and examples in games and hardware options). To provide support for what learning outcomes should be examined and how, the TCF have three levels to guide the focus of learning outcomes for each group of students; (I)ntroductory, (T)ransitional, and (E)mphasized. These levels also reflect the examination where E outcomes need to be examined, T can be examined, and I is not examined. Emphasized also means that examination of a learning outcome should integrate knowledge, skills and attitudes (Westin and Dupire, 2016b).

2.3 IGDA game accessibility open educational resources

Open Educational Resources can be used in formal, non-formal and informal learning contexts, including students on various levels as well as auto-didacts in the game industry. Thus, following the publication of the TCF (Westin and Dupire, 2016a) the first set of IGDA Game Accessibility OERs were published (IGDA Game Accessibility SIG, 2018). While there are many free resources online,

open here means that the OERs are shared with a license that allows a community of educators to help each other in creating, sharing and improving resources; the Creative Commons Attribution-Non-Commercial-Share Alike license. The reason to publish the OERs under the non-profit IGDA banner, was that it provides an industry neutral and non-profit context that both developers and academics can contribute to on equal terms.

The OERs are currently organized in three tracks: Start, Design and Engineer. Start OERs are "basic knowledge for all game developers" (both designers and engineers), while the Design and Engineer OER tracks are more specific for each group. Each OER follows a set of guidelines to make them accessible. Each track has a number of OERs with a title, learning outcomes and disabilities covered. Each OER has a template structure to make them easier to use for learner or educators. (1) Components, such as presentations, spreadsheets, videos or other material; (2) Further reading material, i.e., related resources such as research articles, guidelines with examples in existing games, and game design literature; (3) About the educational resource, such as who has contributed with what and how it can be used; (4) Accessibility considerations, i.e., how the OER itself has been made more accessible; and (5) Source files, i.e., what you need to improve or adapt the OER.

3 Course design support for teaching about game accessibility

Going from OERs that can be used for informal learning and auto-didacts, to courses in formal education requires alignment with learning outcomes and activities. Here, an *activity* is, e.g., a lecture, workshop, seminar and similar that typically takes 2 h with a break. Other activities can be playtests (focusing on fun, game balance, and similar) and usability tests to get user perspectives, as well as study visits to better understand practices of some groups of disabled people, that can take up to a full day each. A *module* is a combination of activities, such as a lecture followed by hands-on practice in a workshop or lab, or a seminar discussing the content that was introduced at a previous lecture and in literature. A *course* is the actual course that students attend with learning outcomes, a schedule with activities and examination criteria to gain educational credits. The activities are here structured in modules and not by course to be more generally applicable.

By mapping modules to the TCF Learning outcomes (Table 1) and filling in whether each outcome is Introduced, Transitional or Examined in the specific course design, it is possible to find gaps in what learning outcomes are met by applying the modules in the course or educational program. According to the TCF, each of the TCF learning outcome should be examined (emphasized) at least once during the students' education, with the exception of Experience (Westin and Dupire, 2016a). Experience "aims to change values and attitudes by gaining empathy through, e.g., simulating disabilities" (Westin and Dupire, 2016a, p. 4) or using personas, but there were concerns how to be able to examine this. However, as was found by Levy and Gandy (2019) it is possible, thus motivating educators to raise the bar and require examination for this. The overview in Table 1 fulfills all examination requirements in the TCF, also for advanced or master level, provided all modules are included. Thus, the examination differs somewhat from the original outline of the TCF, underscoring the need to use the TCF pragmatically, when new knowledge is found in research. The following are *example* modules with activities that have been used in practice to get students started with design and development with accessibility requirements in courses about game prototyping, inclusive design, immersive environments, and human-computer interaction.

3.1 M1. Introduction to game accessibility

This module examines Concepts, Scope and Solutions, whereas Needs, Methods, and Experience are introduced, as seen in Table 1.

3.1.1 Lecture: introduction to inclusive design and digital accessibility

The concepts of universal, inclusive and accessible designs are emphasized. Furthermore, differences between the medical model versus the current social model of disability are explained based on World Health Organization (2011). Also, how the social model focuses on adapting the digital environment (hardware and software) to remove barriers for the individual, in other words accessibility to enable people to participate. Moreover, the scope of people that benefit from accessibility is emphasized, with figures from the World Health Organization but also at the same time argue that accessibility is in general good design for all. In addition, to implement accessibility solutions, two main approaches are introduced where one is based on generic, third-party solutions dependent on standardization (e.g., screen readers), and the other is dedicated, custom-made solutions for the specific application (e.g., voice recordings) with different technical, economical and esthetic implications. Finally, to give some advice on how to learn more about solutions, the four W3C WCAG principles (W3C, n.d.) are briefly introduced.

3.1.2 Lecture: game accessibility introduction

This lecture starts with giving students a historical perspective; one early research paper is Hughes (1981) and further historical facts can be found via (Ellis, n.d.). The Game Accessibility Guidelines (Ellis et al., n.d.), continuously updated since their release in 2012, are also introduced. An alternative to guidelines is a design vocabulary by Cairns et al. (2019), where the authors argue, e.g., that guidelines do not capture the experience of playing a game. However, this is not a dichotomy; both approaches have pros and cons for students, where guidelines focus on specific accessibility features and the design vocabulary on the holistic experience. Further current resources are Game Accessibility Conferences (IGDA, n.d.), the "Can I Play That?" reviews (DagerSystem, n.d.), IGDA GA-SIG Discord channel, the Microsoft Gaming Accessibility Fundamentals Learning Path in late 2021 (Microsoft, 2021) and Special Effect released their DevKit in 2022 (Special Effect, n.d.). This lecture requires continuous updates with current examples.

3.1.3 Workshop: alternative controllers and feedback systems

This workshop aims to raise awareness and empathy among students through a first-hand experience of game accessibility solutions with hardware and software. It is usually perceived as engaging and motivating for students to create similar solutions in their own games. The workshop includes various controller options, a

TABLE 1 Mapping educational modules with TCF learning outcomes for game accessibility.

Below: M# = Module with activity types Right: TCF learning outcomes	Concepts	Needs	Methods	Scope	Experience	Solutions
M1. Introduction to Game Accessibility	E	I	I	E	I	E
Activities: Lecture, Workshop	*L*	*L*	*L*	*L*	*W*	*L, W*
M2. Reflections on Inclusive Design	E	I	I	I	I	I
Activity: Lecture	*L*	*n/a*	*n/a*	*n/a*	*n/a*	*n/a*
M3. Inclusive Game Design in Practice	n/a	E	E	I	I	I
Activities: Study visit, Workshop, Lecture	*n/a*	*S*	*W, L*	*I*	*S*	*W, S*
M4: Playtesting with an Inclusive Lens	I	I	E	I	E	E
Activity: Workshop	*W*	*W*	*W*	*W*	*W*	*W*

large number of buttons, switches, joysticks, eye trackers and more for students to try and configure. Groundbreaking and pioneering modifications of existing games are also included in the workshop. Furthermore, both special games for disabled and high-budget, high-profile (AAA) mainstream games have been used to effectively demonstrate what can be done in a game to make it as accessible as possible, which has been very motivating for students to experience. Furthermore, in response to Cairns et al. (2019), demonstrating the limitations of common game engines (Westin et al., 2018) by using a screen reader software, or gaze control, to try and navigate the game editor interface, is also an eye opener to demonstrate barriers for inclusion of developers (and consequently gamers) with disabilities. For instance, audio games are often made by blind for blind, typically playable with sound alone (Garcia and de Almeida Neris, 2013; Urbanek et al., 2018), and typically with custom made engines. Obviously, this workshop also requires continuous updates.

3.1.4 Examination of emphasized learning outcomes

Knowledge about the TCF Concepts and Scope learning outcomes of the lectures can be examined by, e.g., a written exam. An alternative approach, could be an essay where the students discuss their design work with concepts in course literature, guidelines and research articles, relative to scope and impact. However, to avoid risks of AI tool generated texts, the essay should be combined with a seminar as a panel debate among students, where each group are given a theme with a subset of the concepts to discuss their own game. The teacher acts as moderator, asking each person in the panel questions to ascertain all have a solid understanding of the concepts. The audience are also allowed to ask questions and this often results in an engaged discussion.

Skills related to the TCF Solutions learning outcome can be examined by students taking structured notes individually during a workshop, answering questions regarding how they can apply what they learned in their own games: (1) Which accessibility features can you apply in your own game? Check all that apply [A list of all accessibility features demonstrated during the workshop]; (2) Motivate those that you did not check in question 1. Individual notes make all students active, and the focus on rationalizing those that were *not* checked makes it harder to ignore features without first reflecting about them, which also enables some deeper understanding. The answers can also be used later in the course to follow-up what was actually implemented and continue the dialog with each student. The arguments also reveal their attitudes toward game accessibility, where arguments should be specific related to the game play or game mechanics.

3.2 M2. Reflections on game accessibility

While reflection can be done on all learning outcomes, this module provides a theoretical understanding of concepts related to game accessibility and inclusion, as seen in Table 1.

3.2.1 Lecture: a model to explain the game accessibility paradox

This lecture aims at explaining how accessibility and games can be combined. Many students have difficulty in grasping this and rightfully so. In fact, game accessibility is a paradox; while accessibility is about removing barriers, games are deliberately designed to raise barriers (i.e., game rules and mechanics). Explicating this as a paradox has proven a useful approach as it captures the essence of the design challenge in general. To put it differently, games are the only type of application where designers deliberately make the application harder for the user, but rules are necessary in games. However, there are also challenges that often are implemented without intent; there are for instance few games if any where the core game mechanic is to be able to read text in small font sizes, yet this challenge is often present.

The Game Accessibility Paradox (GAP) and how to solve it can be illustrated by a model (Figure 1) with a thick circle, representing Huizinga's magic circle (Huizinga, 1955), which is a demarcation line made up by strict game rules for playing a game. Sicart (2008) labeled game rules as normative, i.e., something that cannot be changed unless you create a new game, while game mechanics relate the interaction with, and thus the performance (i.e., ability) of, the player when playing the game (inside the magic circle). Also, the dashed circle outline represents unnecessary barriers that can be removed while maintaining the core game play, in essence resulting in game accessibility. The concept of what is necessary originates from Suits (2005) who says "playing a game is the voluntary attempt to overcome unnecessary obstacles" (Suits, 2005, p. 55). However, what Suits refers to is that playing games is unnecessary to survive in the actual world; here unnecessary refers to obstacles (or barriers) to play the game. It should also be noted that with motion and/or location-based games,

it can be argued that the player also is physically within the circle. The performance is then also governed by ability to interact in physical (or built) environments, and not only by controllers and feedback to interact with digital environments. Two main approaches to resolve the Game Accessibility Paradox are either by optimization and only removing barriers unnecessary for core game play (e.g., too small text), or create special games that are designed from the ground-up for a specific modality (e.g., audio games). A hybrid approach is to make modifications (mods) that transform a game into a special game with different game rules, essentially creating a new game.

3.2.2 Lecture: a virtual perspective on abilities and games

This lecture aims at explaining that we as humans do not really "have" abilities, rather that our abilities are 'enabled' in different environments or contexts, with accessible design and technology and what this can mean for game design. This is in line with the social model of disability. What is often missed by students is that computers can represent virtually everything; data in form of binary digits or bits can be defined to represent colors, letters, sounds as well as any type of interaction. This means that computers hold the potential to truly enable inclusion for all. As nothing breaks immersion more than inaccessibility, game developers must learn how to avoid designing any unnecessary barriers in games. This virtual perspective on abilities may require some further explanation, as follows.

The word "virtual" stems from Latin "virtu" and means potential. For instance, the concept of virtual reality then means potential reality. When this potential is achieved there is nothing virtual about it, it is only real. While it is not possible to ontologically reproduce tangibility of the actual world in a virtual world (game), it can be enough for immersion, as long as the user or player accepts those limitations (Grimshaw, 2014). In other words, a virtual world is simply a world where the potential of immersion is *not* fulfilled, i.e., a bad design. In virtual worlds, there are also virtual actions, "an action initiated by a user within a virtual environment and involving (only) objects and persons within the virtual environment" (Grimshaw, 2014), such as interacting with non-player or player characters. Abilities are closely related to the player outside of the game. The abilities to see, hear, understand, move and speak; all depends on the context (situations, environments) and our own functioning, even temporary functioning where a broken arm limits mobility. Thus, to put it in general terms, our abilities are only potential (or virtual) as they depend on both time and space. Digital environments hold the potential for inclusion and accessibility; designers only need to think about how to design them. Furthermore, by allowing a wide range of settings, it can result in a creative space where players can come up with new ways to play, by combining different controllers and settings. While the resulting experience differs, it can even be a better experience than the designer was able to envisage.

3.2.3 Examination of emphasized learning outcomes

The knowledge of the Concepts learning outcome can be examined by a written exam. Alternatively, a panel can be applied here as well, where group of students are given a theme with a subset of the concepts and asked to discuss their own game. The teacher acts as moderator, asking each person in the panel questions to ascertain all have a solid understanding of the concepts. The skills involved is mainly the ability to argue with either text (in written exam) or orally (in the panel). With the reflective conceptual focus of this module, it is a challenge to examine a change in attitudes, but a possibility is to conduct pre- and post-tests of how students view accessibility and abilities before and after the involved activities. If there is a written exam, a post test may be integrated in that exam.

3.3 M3. Inclusive game design in practice

While universal or inclusive design requires inclusion of disabled participants in the design process, there are challenges such as ethics and costs for traveling (Westin et al., 2019). Thus, this module focuses on Needs and Methods as shown in Table 1.

3.3.1 Study visits and guest lecture: learn from practice

Collaborating with a local day activity center for disabled people or NGOs as in Sousa et al. (2022), is a feasible way to bring real life situations and issues related to games into the design process. However, since it is a sensitive environment, great care has to be taken

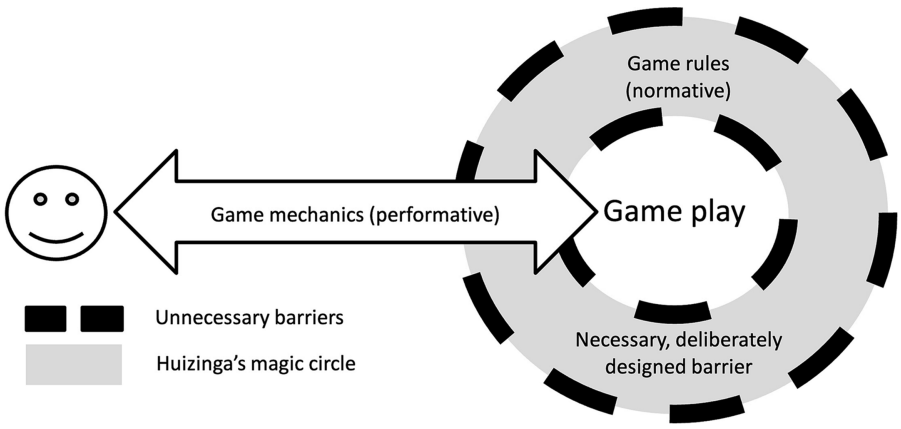

FIGURE 1
Game accessibility model: identifying necessary and unnecessary barriers.

to protect the day center participants. An approach has been to first have a manager from a day activity center as guest lecturer to explain what they do. After this, bring students in smaller groups, around 10 students at a time to visit when the center is less busy, and let the managers demonstrate the different accessibility tools/adaptations and rooms used, and then have a 1- or 2-h meeting where the manager can have a dialog with students, who can also ask questions about games and issues in general, and get information that they can bring to a following persona workshop. Structured meeting notes can be based on a persona template for disabled people: (1) Daily activities or tasks at the center; (2) Disabilities among participants as a group at the center; (3) Assistive technologies used by participants as a group at the center; (4) Participants' goals/wishes; (5) Participants' frustrations; and (6) How to make technology and activities work for participants.

3.3.2 Workshops: creating and validating personas together with practice

In this workshop series students create and validate personas, i.e., fictitious persons based on real life persons and scenarios, with a template persona similar to the structured meeting notes in the previous activity. Data for the personas can be provided via a study visit (above) or by the teacher collecting data before the course or workshop. Personas include text, illustrations and possibly other media, collected in a presentation file. It should also be presented and documented with video and/or screen recording, with voice-over and captioning to clearly communicate what each persona needs and wants. It can also be combined with videos of sketches, mock-ups or functional prototypes of designs that hypothetically could work for each persona. The personas are then presented to the center management to validate that they correctly represent persons that could be actual participants. A modified version should then be handed in and presented once again for center management and teachers. Depending on the length of the course, further iterations of refinement can also be made. With consent from the students and the center staff, the personas can be used later by both other students and the public, to design games or solutions based on these personas.

3.3.3 Workshop: universal access design methods

This workshop introduces a structured method to create universally accessible games, with aid of an existing OER (IGDA Game Accessibility SIG, 2018). The workshop can be started with the OER presentation or video file, followed by conducting appropriateness analysis using the OER spreadsheet file. User attributes of varying limited abilities for the analysis can be derived from previously created personas. The results of such an analysis is a map where it can be ensured that all users have at least one input and one output option that could be used, or preferably, is appropriate or even ideal, and merged into user profiles (Grammenos et al., 2007).

3.3.4 Examination of emphasized learning outcomes

The knowledge about the Needs learning outcome can be examined with the structured meeting notes from the study visit at the day activity center. The skills of the Methods learning outcome can be examined by having the personas validated by staff from the day activity center. The attitudes can be measured in a similar pre- and post-tests as done in module M2, but focus on of how students think about disabled people and their daily lives.

3.4 M4. Playtesting with an inclusive lens

This module focuses on methods, experience and solutions as it is more closely connected to the creative process of game development than the other modules.

3.4.1 Workshop: identifying challenges and opportunities of game accessibility

During development of a game, several iterative playtest sessions as well as usability test sessions are essential (Fullerton, 2019). Inviting a disabled gamer or developer as guest lecturer and play tester is ideal, also for the first playtest, who can play test with think-aloud observation (or only observation if speech or cognitive load with think aloud are barriers). A lecture with the invited person should be done as early as possible, before designing the game to enable co-design. If no disabled person can be engaged, teachers can apply an inclusive lens by using, e.g., personas and game accessibility guidelines and similar resources to identify potential unnecessary barriers for players. In this pragmatic roleplay approach, an inclusive playtest matrix (Table 2) can be applied. The students are asked pre-playtest to outline core game mechanics, see column 1 in the table. The teacher plays through the game and simulates different visual, hearing, motor, cognitive, and speech limitations, based on pre-made personas. The teacher takes structured notes in the matrix to identify unnecessary barriers in the game. From the example in Table 2 the teacher can summarize the barriers, that can be given as individual assignments to solve. Then students can work with game accessibility guidelines to find solutions to the barriers, as basis for requirements.

3.4.2 Workshop: elicit requirements of potential solutions of game accessibility

This workshop aims at providing a structured approach to elicit requirements of the potential barriers and solutions found in the previous workshop. A table of requirements based on Benyon (2019) can contain a summary with a one-sentence description of the requirement; Sources with reference to guidelines and current research; Reasons that relate to identified barriers; Measurable fulfillment criteria for what is needed to address the requirement, and Priority of what must, should, could or would be implemented. This list is then used by students to focus their work and teachers to follow-up during playtest sessions. To find out to what extent the defined requirements can be played by all personas, the Universal Access Design method described earlier in the Open Educational Resources section can be applied, and to create user profiles in the game. The requirements should be checked with an invited disabled gamer, developer or with a NGO or day center.

3.4.3 Workshops: iterative evaluation of prototypes with players

This activity consists of two iterative workshops to prepare for the second and third playtest. The second playtest is done with non-game students (and an invited disabled gamer, if possible). The game should be an alpha version, i.e., where some limitations and bugs can exist. A

TABLE 2 Example of an accessibility protocol for testing a playable version of a game.

Game project group# Game mechanics	Visual	Hearing	Motor	Cognition	Speech
Finding the way in 3D to exits from rooms	The exits are too hard to see and lack sound	No accessibility issue found	The camera control requires fine motor control	There are no hints to find the exits	No accessibility issue found
Discover hazard by looking around	The traps have low contrast, lack sound	If sounds are added to traps, add captioning too	The camera control requires fine motor control	It is hard to know what are hazards and not	No accessibility issue found
Solving puzzles that have hints with voice and text	The voice hints are hard to hear due to other sounds. The text is too small and low contrast	The text hints do not match what is being voiced. Sound effects are not captioned	The levers that are used to solve the puzzle require extensive and combined button presses	The hints are too vague, with difficult words, and time is not enough	Requires speech collaboration, no text chat available

playtest script is written according to Fullerton (2019) with added questions regarding the requirements. Methods for data collection are limited to either on concurrent or retrospective think-aloud observations, selected based on the game mechanics and with regards to cognitive load for play testers and time available during playtests. Observation with notes only can also be used if think aloud is not possible for some disabled participants.

The third playtest is done with a beta (feature complete) version in a more public setting to reach a broader audience. The students are asked to iterate the playtest script based on what worked well or not at the second playtest regarding instructions to play testers, ethical concerns, data collection methods, and the results that was compiled. Furthermore, a log of game events with time stamps is added to gather quantitative data that is hard to capture with observation alone. Also, an external file with extended settings for rapid testing of various scenarios during the playtest without recompiling the game. Depending on the length of the course, a fourth playtest can be done with the final version of the game, iterating with the methods used for the third playtest.

3.4.4 Examination of emphasized learning outcomes

The knowledge about, and skills to apply, the Methods learning outcome can be examined by both the group assignment (Playtest script) and the individual or pair assignment (prototypes to address barriers), as well as the formative assessment done during playtest sessions and workshops. The knowledge regarding the Experience learning outcome can be examined by their analysis of results from playtests. Finally, the students' skill in implementing solutions is examined by both participating at playtests, taking notes of what works and not compared to the list of requirements, and also asking students to hand in screen recordings with voice-overs, which is easy to play back during examination compared to game prototypes. In this module there is no assessment of attitudes, as it is well covered in the other modules.

4 Discussion

The purpose of this paper was to explain how inclusive design and accessibility can be taught to students in higher education and universities, which has been done by presenting example modules. The modules should be easy to implement or adapt as they mostly consist of lectures and workshops. However, the third module takes more effort as it requires collaboration with a NGO similar to Sousa et al. (2022) but it is time well spent and can strongly be encouraged, in agreement with Sousa et al. (2022). Going forward, the activities listed in Table 1 for each module are examples of what the author has done in practice, but this does not mean that those marked as n/a are inapplicable for other teachers. The table provides a further detailed framework (based on TCF) that is meant as a starting point to be discussed and modified on a local level by peer teachers.

Furthermore, the paper has presented a brief review of developments in the field with a few key research papers, and grounded game accessibility in the wider field of accessibility and the social model. Also, as game accessibility often is perceived as a paradox by people unfamiliar with the concept, a model to elicit this paradox and an explanation of how to approach it has been introduced. For instance, methods to teach how to prioritize accessibility features relative to the game itself. Additionally, to explain that abilities are dynamic over time and space, the concept of virtual abilities was also introduced.

In the author's experience, bachelor-level game students tend to focus on design and/or programming, but many struggle with the more theoretical parts of higher education, to go from design, to design science. Thus, introducing concepts and methods may require an extra effort by teachers, and perhaps even more so within a specific field such as game accessibility. As concepts, or definitional knowledge, lay the foundation to express and communicate other types of knowledge (Johannesson and Perjons, 2021), and methods are key in science, merging scientific rigor with industrial relevance and creative thinking, can be a challenge for both teachers and students. In contrast, the other learning outcomes of the TCF are relatively easy to communicate to students, perhaps as they are easier to explain with numbers and examples, i.e., needs, scope, and solutions. Experience is harder but through study visits, personas and co-design with disabled people it is possible to overcome this educational barrier, as students are typically very responsive to accessibility, when they learn about the actual situations disabled people experience in real-life.

When starting to teach about game accessibility more than 20 years ago, the author did not realize that the teaching activities could be of interest to other teachers. Thus, there was no ambition

to document the process. This is also the main shortcoming of this paper, that it is based solely on the author's own experience of teaching. The modules are here also organized as more standalone than they have been applied in practice within the author's courses, with the aim to make the modules more generally applicable for peer educators.

Future work involves transforming the modules themselves into open educational resources, organized based on the TCF, and make detailed evaluations of them. Also, developing more personas based on research such as Theil et al. (2022) is necessary, and making them publicly available would be very helpful for design tasks in education. It can also be discussed to what extent the TCF can be applied in other areas for accessibility beyond games. Especially, in related and emerging accessibility fields such as extended reality or XR applications, where the author also teaches, e.g., design and development of immersive environments. Hopefully, this can motivate peer educators to also contribute similar OERs and modules in a common repository, aiding each other as a community of educators to develop best practices for teaching about game accessibility in higher education.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article.

Acknowledgments

The author would like to thank Dr. Jérôme Dupire at CNAM, France and Capgame.fr for the previous co-work with the Tentative Curriculum Framework, without which this paper would not be possible to write. The OER structure mentioned in the paper are available on the IGDA Game Accessibility SIG website (igda-gasig.org) and the author would also like to thank the organization management for hosting the OERs and maintaining the website. Finally, the author also would like to thank the three peer reviewers of this journal for insightful and detailed comments on the manuscript.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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