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Article

Redesigning for Inclusion and Accessibility: Lessons learned from an educational game

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Abstract

Context: Educational gameplay can foster transformational changes, especially when learners feel games speak to their experiences. Designers create barriers for players when products don't meet accessibility needs or when games use language, physical depictions, or characters that exclude or alienate players. Purpose: This study examines how an educational development team used a redesign process to address the accessibility and inclusivity barriers present in an existing 12-year-old educational game focused on food safety content. Methodology: The research follows a case study approach, detailing the redesign process carried out by the original product team. The team applied inclusive design theory to identify and revise gameplay and character elements that posed barriers to players with visual, hearing, motor, or cognitive needs. The team also worked on cultural representation elements of the game. Findings: The study highlights practical design compromises and decisions that successfully enhanced accessibility and inclusivity without compromising the game's effectiveness. Originality: This work advances the field by providing concrete, real-world examples of applying inclusive design principles in revising a previously published educational game. Impact: The findings offer actionable guidance for other development teams seeking to create or revise educational games to support various players and needs, contributing to more equitable and engaging learning experiences.

1. Introduction

Designing products or interfaces with inclusion in mind helps teams make games which are accessible and relatable to people with diverse identities, backgrounds, and needs [1, 2, 3]. Designers of educational games (also called serious or transformational games) should engage in processes at every stage of design that give consideration to learners' needs. These include accommodations for vision, hearing, motor control and cognitive needs.

Learners also need representation, which can be influenced by the diversity of the team creating the game, the intent of the developers in determining content, the characters and environment of the created world, and the access learners have to the game [4].

Despite growing interest from designers and developers in inclusive design efforts, integrating specific processes to make games more accessible and representative is still challenging for many teams. Inclusive design can be complex, especially in educational games, where each game must balance engaging game mechanics with specific content. While there is no one-size-fits-all solution, design teams can intentionally engage in better design of inclusive games. As part of this process for educational games, design teams and researchers have been increasingly sharing resources and studies towards inclusive practices for games and entertainment media [5, 6] as well as for educational media such as learning games and learning environments [7, 8, 9].

This study describes the efforts of one educational design team working to be better at creating inclusive games. In this case study, the team intentionally redesigned a successful educational game to make it more inclusive by paying attention to representation and accessibility. While this article focuses on work during the redesign of a particular game, it is meant to convey the learning process a team takes in reviewing a game for redesign, underscoring the impact of the entire team viewing the game through the lens of inclusive design over many months. The study details the team's process during the redesign and development and provides actionable and realistic steps to develop inclusive games and build design teams who are better able to make all their games more accessible and representative.

2. Inclusive design: a deliberate and ongoing learning process

Inclusive design creates products and systems for and with people of diverse identities, backgrounds, and abilities [2]. This approach involves intentional practices to remove barriers to interaction, support diversity and representation, and promote equity. Through inclusive design practices, design teams can make their work more inclusive and accessible to a broader range of users. In a broader sense, inclusive design promotes equality and helps combat inequalities, aligning with the United Nations' 17 goals for sustainable development [10]

Inclusive design is not about finding a perfect solution but rather is an ongoing learning process [11]. It starts with recognizing the diversity of users and their needs. This may require teams to challenge their own assumptions and biases. By doing so, teams can identify potential barriers the design solution may create or remove for certain groups or needs, ideally recognized during the design phase. Inclusive design involves designing with and for the needs of users. It is an ongoing process, because every project is different and requires different solutions to support a wide range of users' needs.

This study is grounded on the **social model of disability** and follows a **reactive approach.** From the social model of disability perspective, accessibility lives in the product, not in the user; this concept is a way of describing the power of design to include or exclude people. Through the social model of disability lens, people are not disabled by their impairment or differences but by society's barriers and disabling factors [12]. Design creates many of these barriers when disregarding people's needs and differences. It means the disability is a mismatch between the design and the person's needs, rather than a personal health condition [13]. To eliminate these barriers, designers have been using either a proactive or reactive approach. The proactive approach emphasizes creating inclusive and accessible solutions during the design phase, rather than viewing them as an afterthought or an accommodation. Conversely, the reactive approach focuses on developing accommodations or solutions to support users' diversity, once these needs are recognized, for existing tools or interfaces [14]. Since this study involves a redesign, we categorize it as using a reactive approach.

Inclusive design needs deliberate actions. Human-Centered Design (HCD), for example, is an intentional and effective approach for creating products and interfaces that prioritize users' needs. Over time, through the lens of the HCD approach, designers and teams have developed effective design methods that identify user needs, test design concepts, and co-design with users to ensure that the design being created (e.g., interface, system, product) meets the needs of the intended audience [15]. Even when using a human-centered approach, design teams still have biases, mostly implicit, and prejudgments, including against certain societal groups, particularly minorities and marginalized communities [15]. It's important to ask whose needs are being considered. Who will have access to the product? Who will be represented (or misrepresented) in the product? Design team bias can result in design solutions that are only suitable for a homogenous population or lead teams to believe there is an "average user." Design has the power to bring social transformation, but it can also be used to suppress differences among people and exclude communities by not providing access, representation, and accessibility [2, 13].

The human-centered design approach is still widely regarded as effective, but there is a growing trend towards a more inclusive approach called *humanity-centered* design. This approach highlights the need for sensitivity to biases and prejudices against certain societal groups, recognizing that design has not always been fair or equitable to these groups. Humanity-centered design places greater emphasis on designing with and for communities and seeks to facilitate the design process by considering the concerns and needs of the communities involved. Additionally, this new approach emphasizes the entire ecosystem, including humans, other living creatures, and their physical environments [15].

When it comes to designing games with an inclusive approach, several factors need to be considered, including the composition of the team, user participation in the project, the portrayal of the game world (including characters and environment), and accessibility features that cater to users' needs (including hearing, motor, cognitive, and vision needs) [4]. These factors are essential for educational or transformational games that aim to enact change in learners with regards to a specific content or topic [16] and that enhance learning opportunities via graphics and multimedia [17]. Inclusive design for educational games involves an additional layer that ensures that culturally informed teaching and instructional design practices can accommodate learners' variability [18], enabling them to receive, process, and comprehend the content effectively.

While this case study focuses on a redesign of an existing game, inclusive design should not be viewed as a final step. Rather, inclusive design processes inform the entire design process, from beginning to end [19, 20, 21, 22]. However, current literature lacks documentation of redesign as a process through which professional design teams reflect on and enhance educational games by making them more inclusive. It is common to find literature that investigates the impact of using game redesign as a learning opportunity for students to develop specific competencies and skills [23, 24, 25]. These findings suggest that redesigning games with students improves problem-solving skills and systems thinking and increases participation and creativity in learning. In sharing the details of a redesign by a professional team, researchers can document how inclusive design can improve specific features of a game, and comment on ways the structure of a team improved the game. Then, readers can extrapolate how a game can be designed for accessibility and inclusion from the start.

2.1 Inclusive game design through redesign

Developers and researchers increasingly recognize the significance of inclusion in games. Research on this front focuses on two connected areas that lead to inclusion: accessibility and representation. Although often pursued separately, both perspectives yield important findings on how developers can create inclusive games for various needs and players and how game design may be used to promote inclusion in society. The potential of game design to strengthen social inclusion rests on games' power to promote meaningful interactions, which can remove barriers between groups, inspire empathy, and enhance social and developmental abilities [26]. When games facilitate

collaboration between players with different skills and diverse backgrounds, everyone benefits from the experience [20].

Accessibility in games describes how the game system and interface support users' needs, ensuring that users with various needs can interact with the game to its fullest purpose while having a good experience. As the awareness of accessible games increases, design teams have a significant need for practical tools and processes to make games accessible. Developers and researchers have created a variety of tools, including an analysis tool for game accessibility developed by Larreina-Morales [5]; Anderson's [6] ground-floor approach to making video games accessible; guidelines proposed by Kulpa, Perry, and Amaral [8] for designing accessible virtual learning environments; and a set of inclusive design principles focused on educational media design from the lead author of this study [9].

Representation in games has two interconnected aspects: first, **who is part of the design and development team?** This considers the diversity of the team making the game, and the voices and perspectives that are heard and considered during the design process. Despite progress, there is still a lack of inclusivity in game design teams [22], which tends to lead to stereotypes in game worlds and character development [27, 28, 29]. However, professional development of that team, inclusion of members of the target audience in decision making, invitations to consultants or stakeholders, and extensive testing and focus group reviews can counter biases of teams. The second side of representation in games is **how the game portrays individuals, environments and actions**.

Research on character representation highlights the significance of diversity, emphasizing its role in enabling minoritized groups to identify, feel represented, and gain a sense of belonging. Additionally, increasing the diversity of characters and the frequency of players seeing characters they share identity with reduces negative stereotypes about these groups, helping to reduce the spread of negativity to other mediums or situations [30]. Representation has a profound effect on players' sense of belonging within games spaces, and it helps strengthen their perceived relevance in society.

3. Method & Approach

This case study presents qualitative research in the field of design. Methodologies for using case studies in the design field include documentation of the process and discussion of findings with designers using a variety of data to understand a complex phenomenon [31]. This research team collaborated with a team of game developers to thoroughly investigate the complexity of a game redesign process for inclusion. The development team included various professionals: a studio manager, a programmer, three artists, two instructional designers, a researcher, and a content expert on food safety.

The research and development team collaborated in this process over 15 months. The research team tracked and documented activities and fostered intentional discussions around accessibility and inclusive design. Inclusive design and accessibility frameworks guided reviews and discussions [4, 32]. As part of the redesign process, the team engaged in user testing in an interactive process to refine the game. To understand the phenomenon of the redesign process and ways to make educational games more inclusive, the research team used two primary sources of data from the design process:

- **Game design document:** During the redesign process, the research and development team met many times to discuss design and development decisions. Discussions during those meetings produced the central analysis, reflection, and creative ideation of the redesign. In those meetings, the team made compromises, defined plans, and articulated ways to make gameplay accessible to player needs. The team used an internal game design document to document every discussion and decision made throughout the design and development phases of the redesign process; this study uses these notes as a data set.

- **User-testing journal:** the team conducted many user-testing sessions with youth (the intended audience of the game) throughout the design and development of the game. The testing process included five early formative sessions and five late formative/summative sessions, with a total of 100 user gameplays. Some individual users tested more than once at different stages. Sessions covered design phase demands, for example, getting feedback on early design concepts for characters, and development phase demands, such as testing specific interface elements and game mechanics in beta versions of the game. The user-testing journal produced from this process includes data from group discussions, video closet interviews, and gameplay observations. Because issues related to accessibility and representation were heavily tested, discussed, and observed during the gameplay user-testing sessions, this journal speaks to the required changes and successes of the inclusive design process. As part of an outreach program, the Learning Games Lab hosts user testing and Think Tank sessions throughout the year, collecting users' feedback on different products in different development stages. The New Mexico State University institutional review board approved all the lab sessions, and researchers collected participants' assent and their legal guardians' consent. The 100 user gameplays testers came from our Lab technology program. Consultants are selected from a pool of students applying to take part in an online or in-person half-day, full day or weeklong session. Those consultants participate in activities related to game design, digital literacy, and critical review of digital media. Consultants are selected from the school in our community, a low-income area. In our university recruitment process, we do not exclusively select consultants with disabilities. Such information is not directly tracked. Parents can request accommodations, which follow a specific university process. Since we do not have access to the representative sample of user needs, our design process incorporates consultation with experts who interact with a vast range of user needs.

4. Redesign Process

The redesign process was for the game *Ninja Kitchen* (Figure 1), an educational game about food safety, designed for middle school audiences (11–13 years old). The game was a planning-based food service simulation played with time pressure. In 2011, with funding from USDA-NIFA (United States Department of Agriculture National Institute of Food and Agriculture), the Learning Games Lab collaborated with Rutgers University to design *Ninja Kitchen* (2011), which uses the types of food preparation done by learners in this age group to teach vital safe food handling skills to prevent foodborne illness. Players served as lead chef in a fictional kitchen where they prepared food and served customers by following food safety best practices, including handwashing, avoiding cross-contamination, and cooking at the right temperature. *Ninja Kitchen* was popular with youth. With more than 4 million plays, the game proved effective in reaching a large population with its educational content. A study of more than 900 middle schoolers showed that it engaged participants and shifted their knowledge, attitudes, and intentions around food safety [33].

Figure 1. Title screen (left) and gameplay screen (right) from Ninja Kitchen

In 2020, the game became unavailable with the discontinuation of Adobe Flash; as web browsers dropped support for this plug-in, the game was no longer playable. With new funding from the Extension Foundation, the lab redesigned the game to be playable in any web browser and to follow inclusive design best practices, including the intent for increased accessibility and representation.

The new game, *Theme Park Kitchen* (Figure 2), offers the same basic transformational activities and engaging play as *Ninja Kitchen.* However, the new game can be completed using either mouse/trackpad or keyboard commands and is not reliant on clicking precision. Players are able to familiarize themselves with gameplay within the first level with little to no repercussions. Learners can play *Theme Park Kitchen* individually or collaboratively in formal settings (classrooms) or informal settings such as after-school programs. The game can be played on a computer, laptop, or tablet using a web browser. The game has five themed areas, with three levels in each area, progressively addressing food safety content. Gameplay addresses the following content:

- Washing hands and surfaces
- Cooking meat and combination foods to the proper temperature
- Avoiding cross-contamination
- Applying multiple food safety concepts when cooking

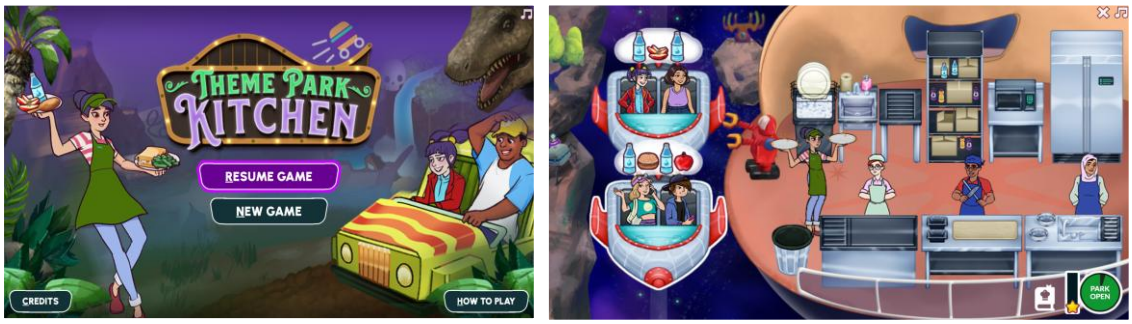

Figure 2. Title screen (top) and gameplay screen from *Theme Park Kitchen.*

For this case study, researchers have translated the steps taken by the design team into recommendations to assist other developers in approaching game design in more inclusive ways. They provide five key steps as guidelines, with specific examples pulled from the findings of the research on this process.

4.1 Step 1: Use a framework for Inclusive Game Design

Over the past four years, the Learning Games Lab team has intensified research efforts regarding accessibility and diversity in their educational media, including games, interactives, and virtual

labs. Their comprehensive framework for inclusive design of educational media [4], accessibility framework for developers [17], and documented redesign processes for accessibility in educational settings [34] supports the development team with vocabulary, specific steps, and intentional actions toward inclusion. Additionally, this research informs the team's ongoing iterative process, where data from case studies and postmortems of developed games inform and refine their design process and practices. Compared to other frameworks, this framework accommodates an educational design setting where content experts, artists, instructional designers, and programmers work together to update educational resources under time constraint, given changes in technology and limited funding. The framework was created for and by our team, to specifically meet the needs of inclusivity and accessibility in educational games.

Using the framework for designing games for accessibility (figure 3), the team reviewed and identified accessibility barriers to users receiving and processing information and being able to interact with the game interface. The identification of barriers was guided by four main areas of needs (i.e., visual, hearing, motor, cognitive) on a spectrum from low to high. The framework for designing for diversity (figure 3) guided the team in revising for diversity and presentation of the game's building elements, including characters, stories, and environments. Also guided by the framework, the team deeply reflected on cultural sensitivity and possible biases incorporated in the game. The priority for this redesign was to address the cultural sensitivity issues with the ninja theme by redesigning visual and narrative aspects of the game to avoid cultural appropriation. Secondary priorities were to address diversity in cognition (by softening the time-based aspects of gameplay and making instructions more concrete) and dexterity (by adding keyboard functionality).

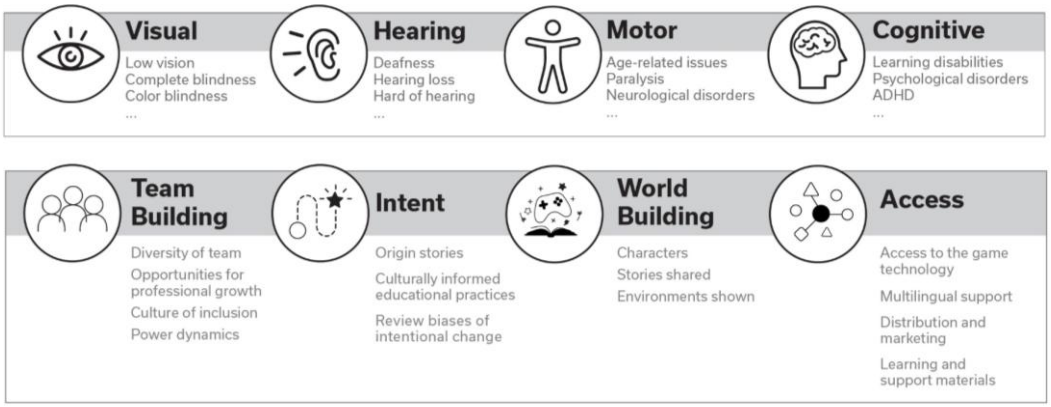

Figure 3. The framework for designing games for accessibility, based on author [4].

Design teams can use frameworks as a starting point to articulate their own goals, values and approaches. Before they use any given framework as a guide for a specific game, a team can review frameworks to develop their own guiding structure (asking if each component of the framework holds true for their team), eliminate anything they disagree with, or discuss what may be missing. This strengthens the team for all future games and helps educate each member of the team regarding the importance and specifics of any individual component. It could also be helpful for a team to first use an existing framework to guide design of a game – and then revisit the framework to develop their own. Frameworks give development teams a blueprint to use in reviewing their games and game design plans. They can be used in the brainstorming process to help all members identify any gaps in their thinking and challenge biases. For example, a team who has developed the key ideas for their educational game could use the frameworks shared here to review their work, asking if their game could be improved for users with varying needs in visual, hearing, motor or cognitive access. They would review the team that developed the game to identify any missing voices, discuss

the intent of the game, and do a dive into the proposed world, establishing goals for the game regarding representation. In the design stage, teams could also begin thinking about how users will access the game, and what support will be needed for distribution, or if the selected devices will reach the appropriate audiences. Use of the frameworks can also guide teams in articulating specific challenges. By having a framework as a starting point, the design teams are then able to move through the next steps in improving their game for all audiences.

4.2 Step 2: Identify key details specific to your game

As a first step in the redesign process, the team hosted a gameplay session of the original game, *Ninja Kitchen*. Members of the development team (around 15 people) were invited to join the session to review, play the game, and discuss. The process invited people with multiple perspectives and backgrounds to review the game. A total of 9 team members participated in this session. The session occurred in the Learning Games Lab space; some members joined virtually using Zoom. At the beginning of the session, a researcher gave an overview of the project and the goals for the session: 1) identify accessibility and inclusion issues in the game and 2) discuss ideas to mitigate those challenges. At this stage, the goal was to identify as many issues as possible with the game, and after that, to prioritize and make decisions based on budget and timeline. The team played the game for 30 minutes. Most of the team members had extensively played the game prior to this session. During gameplay, a team member took notes on comments and issues verbalized by the team. A discussion was also held after the playtime. The session ended with a long list of issues. The main issues, and their resolutions, are summarized in Table 1.

Table 1. Main accessibility and inclusion issues identified in the game (qualitative data)

Inclusion category	Issue	Resolution
Accessibility	Clicking and dragging interactions can be barriers for users with motor needs.	Updated game using clicking, not dragging functionality.
	Time-based pressure mechanics can be a barrier for players with cognitive needs.	Updated game allows main gameplay without time pressure.
	There is no audio narration for text elements of the game.	Not resolved.
	Controllers are only based on mouse clicks.	Keyboard functionality added.
Diversity & Representation	Character stereotypes in representation of overweight customers and customers with bad posture.	Character representation updated.
	Cultural appropriation via the ninja theme and ninja characters.	Complete replacement of theme to a theme park restaurant.
	Cultural appropriation via the typeface used for the game (typographic mimicry).	Typeface updated.

Different from a new game design, a redesign process allows the team to play the game through the lens of a framework to identify key elements that are not inclusive. The team can categorize or

group these elements systematically. This strategy can serve as a powerful exercise for the team, training them for future projects and shaping their thinking towards inclusive design decisions.

4.3 Step 3: Resolve conflicting decisions

Once the large group team identified issues with the game, the next step was to make decisions, prioritizing changes and making compromises based on the project timeline and budget. For this level of decision, the team participating in meetings and decisions worked directly on the project. The team conducted several meetings to make compromises, because not all the accessibility and diversity issues identified could be completely addressed, and not all the possible changes for the game fit the project scope.

4.3.1 Accessibility Challenges and Decisions

The team began with ground-floor accessibility features such as providing proper levels of color contrast and color blindness between interface elements, typeface readability (such as size and typeface choice), tutorials and onboarding mechanics, content appropriateness for intended audience age, and UI visual clarity. Next, the team prioritized two major new accessibility features during the redesign: **keyboard navigation and no-time-pressure gameplay.**

Clicking and dragging items was a main mechanic in the original game, where players needed to select, click, and drag food items to plates or utensils. Understanding that players with motor needs may struggle with this mechanic, the team wanted to change that by removing the possible barriers and improving the gameplay experience. The new version of the game was designed to be played using a computer trackpad or a mouse, **but it is also possible to play it entirely on a keyboard**. We intentionally designed the game this way to provide an alternative to clicking and dragging elements during gameplay. Playing the game using keyboard control benefits users with motor needs and improves the overall experience, allowing players to be more agile while serving customers. Based on the feedback from user testing sessions, it was found that players appreciated playing using the keyboard and performed better in the game. User feedback also guided the team in providing game controls through the keyboard keys "WASD," commonly used to play games, rather than the arrow keys (Figure 4). Additionally, players can use keyboard shortcuts to improve gameplay, such as using "M" to merge food items or "V" to control volume and sounds. These shortcuts support players who become familiar with the game and want to take quick action.

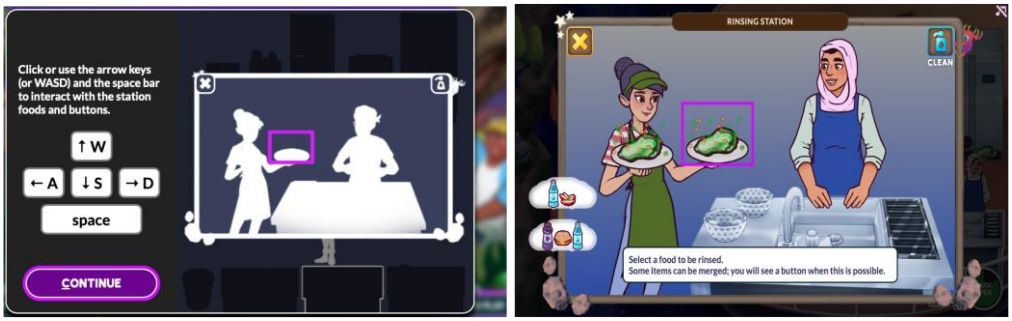

Figure 4. *The Theme Park Kitchen* game includes a keyboard control feature that allows players to control the game using the keyboard.

Time pressure is popular in many games, giving players a thrilling challenge that tests their ability to think and act quickly. However, it's important to remember that not all players perform well under time pressure. For some, this mechanic can be a frustrating barrier preventing them from enjoying the game and progressing – or leading them to adapt gameplay [35]. As game designers, it's crucial to consider the needs of all players and create an inclusive gaming experience that everyone can enjoy, regardless of their cognitive or motor abilities. By doing so, we ensure that

everyone has an equal opportunity to experience the excitement and joy of gaming. However, time pressure was a main mechanic of the original game; removing this element impacted the entire gameplay and required more testing. After many meetings, discussions, and brainstorming, the team made a compromise in the game. The team intentionally removed the time pressure, replacing it with a star system.

In *Theme Park Kitchen*, each level lasts for a specific amount of time, with each level getting progressively harder but still with some leniency. The time allotted represents how long the park will be open for business during that level. In addition, there is a progress bar with a star, which shows how far players have progressed in a given level. The timer starts when players begin the level and ends when the park is closed, meaning no more customers will arrive. However, players can still finish serving the remaining customers, using any amount of time they need. The gauge on the left side of the screen fills up as players deliver food, and if they manage to fill it up, they earn a star for that particular level (Figure 5). Players who act quickly enough will be able to get enough customers to fill the gauge and earn the star. Players who need more time to serve customers will still pass the level if they do not make anyone sick, but they will not earn the star.

During testing sessions, we experimented with different time settings to make the game challenging yet forgiving for players. Our team received positive feedback from the game consultants, who enjoyed being able to finish the level and serve customers once time was up and the park was closed. Moreover, the game has two possible endings: an expected ending and a special ending. Players can unlock the special ending by earning all the stars in the game. Earning all the stars unlocks "master mode," which allows players to play the game with special park merchandise, such as dragon boba and dino nuggets.

This compromise made in the game has allowed more players to participate and enjoy it. However, the team acknowledges that it is not a perfect solution and it can still cause frustration for players who may be unable to obtain a star. Additionally, the removal of time pressure added a lot of work to the team's timeline, requiring more testing and adjustment of gameplay elements that were not originally intended to be changed. The team’s decision to prioritize this feature was a tradeoff with implementing other accessibility features such as translation to another language or adding audio narration.

Figure 5. Left – *Ninja Kitchen*, with time pressure for level and customers; Right – *Theme Park Kitchen,* with a star system and no time pressure.

4.3.2 Diversity and Representation Challenges and Decisions

As a starting point, the team needed to address the question of whether using ninjas (a cultural identity from feudal Japan) as a theme in a non-profit game was a form of harmful **cultural appropriation.** Cultural appropriation has been extensively discussed in the literature (e.g. 36, 37], including discussions focusing on the harm of this appropriation in games [38]. The line between cultural hybridization [39], cultural appreciation and cultural appropriation is delicate, especially in a globalized and highly connected world. Ninjas have appeared as fictionalized heroes in Japanese literature as well as in American literature and culture [40]. It is not within the scope of

this study to discuss the topic in depth, but merely to describe why the *Theme Park Kitchen* team considered using ninja theming to be cultural appropriation and decided to remove it from the game.

During the original game design process in 2010–2011, the ninja theme seemed to the designers like something "fun" to incorporate into a cooking game for middle scholars, allowing the team to create engaging and beautiful visuals. In the aughts and early 2010s, ninjas were a phenomenon in Western youth culture, appearing in toys and imaginative play [41] in many roles, divergent from their historical context. Designing for this audience of middle school youth, ninjas seemed like an effective way to engage players; this was confirmed during formative testing with youth during the original game development. However, through a diversity, equity, and inclusion lens, appropriating the iconography of ninjas in a "fun way" becomes potentially offensive, as other game scholars have noted [42]. Considering that none of the team members or stakeholders for the project had cultural ties to Japan, they were outsiders (a term used by [36] to describe non-members of a culture) making inferences and representing a historical identity without a deep understanding of its cultural basis. Design by outsiders creates a superficial and stereotypical representation of a culture. Through the lens of Young's [36] study, this would be subject appropriation, when a group outside a culture represents members or aspects of another culture. Because of that, the team decided it was best to change the theme and design.

The team explored various theme ideas internally and during design activities with youth during user-testing sessions. Immediately following each testing session, reviewers compare written notes and observations and discuss with each other. They agree on what was observed, making specific notes about conflicting perceptions of what happened, or inconsistent responses of consultants. Themes such as different cuisines, theme parks, acrobats, and traveling kitchens were part of this formative testing. The team decided on the theme park option because it allows players to explore different kitchens as players progress in the game, visiting various park areas. This theme also gave the art team plenty of opportunities to provide engaging graphics, which middle school youth consistently name as central to their gameplay experience.

By redesigning the game theme, the team also reviewed all the characters from the previous game through a lens of representation. The team intentionally checked for possible stereotypes or tropes, using a methodology from inclusive design [4]. All the previously ninja-identified characters (figure 6) were redesigned, as a step away from cultural appropriation. This was a challenging process for the team, since the ninja element of the art was foundational to the game's aesthetics. The team also took the opportunity to make the main character and the kitchen helpers more diverse in culture, gender, and race. Additionally, the customer characters from the previous game were redesigned to reflect a better understanding of diversity in body shapes, age, hairstyle, race, and gender (figure 7).

Figure 6. Top row – Previously ninja-identified characters; Bottom row – New character designs for *Theme Park Kitchen*

Figure 7. New and more diverse customer character designs.

Resolving conflicting decisions is an integral part of the design process for any game, whether it's a new project or a redesign. Factors such as budget, timeline, and design requirements all influence the team's decisions regarding the final design. During a redesign, the team must utilize both creative and technical tools to ensure the game is inclusive and accessible. This is especially important because some features may benefit one group of players while making it more challenging for another group. Teams need to balance the needs of everyone involved and make compromises, recognizing that there may not be a single solution that works for all users. Accommodations and customization may be necessary to address diverse needs.

4.4 Step 4: Implement development with consistent review

As part of any game development process, once design decisions are articulated the team can move to the **development of game assets**, including characters, scenery and other visual assets needed for the game. Additionally, the team starts working on the code and implementation of the game. The development phase for *Theme Park Kitchen* followed a series of formative testing sessions and internal and external review.

The redesign process of *Theme Park Kitchen* took 15 months, including design, production, and user testing. As with any other game development in the Learning Games Lab, the team performed many internal and external reviews throughout development to ensure the game met the intended audience's needs, which included accessibility and representation needs.

While redesigning the game, the team conducted internal reviews through meetings and checkpoint assessments. Senior team members provided feedback on art assets and gameplay decisions. As a part of the iterative process, internal reviews supported changes and clarifications about the decisions made. This strategy added an extra layer of inclusive design verification to catch any issues that members of the project were overlooking. During the development process, a reviewer requested that the team ensure that no character gestures involving hand movements could be perceived as offensive in other cultures. Additionally, while reviewing the game's art, an internal reviewer expressed concerns regarding the clarity of some food art in the game, as it might lead to confusion among players. Following the test with users, food art assets were redrawn to fix the issues raised by reviewer and users.

External reviews were an essential part of the project. The funding agency for the project provided an external review panel. These personnel received monthly updates on the project and gave the development team feedback to support the project process. As the project involved redesigning a game, those meetings were used to get feedback on inclusive elements such as character representation and game accessibility features. This external review process helped us add an extra layer of inclusive design review for the project. For example, one of our external

reviewers, who is African American, expressed concern about the portrayal of African American characters in the game. She voiced her frustration to the team that African American characters are frequently portrayed as overweight in a stereotypical manner. This consideration informed the design of characters in *Theme Park Kitchen.*

Also as part of external review, user testing sessions with youth ages 11–13 provided the team with valuable reviews. Youth tested the game at five stages of game development between September and December of 2023. They gave extensive feedback about gameplay, art, usability of the interface, and learning outcomes. Key feedback led to the team adjusting how the game delivers "stars" and how players view the kitchen timer to clarify how actions map to game achievements. This change was part of one of the biggest accessibility changes in the game, removing time pressure. Youth also helped specify foods that needed to be disambiguated graphically, including steak salad, chicken salad, corn dog, and green beans. Other findings related to how the game teaches about cross-contamination. Youth showed developers why they felt confused by a kitchen environment that included optional “clean” buttons on the microwave and washing station. From an accessibility standpoint, one observation from user testing was that players who used the trackpad instead of the mouse often used a combination of trackpad and keystrokes. Youth also suggested that keystrokes map to WASD, in addition to the arrow keys, to match their expectations from other games. Youth testers found some important, small bugs, such as one that allowed users to wash a hamburger, which were recognized and corrected earlier due to their participation. Overall, formative testing helped the development team to see which parts of the game were engaging and which were challenging and how interaction among players outside of the game helped cement game learning.

4.5 Step 5: Document the process

Documenting the steps and actions is helpful for the team as part of the redesign process. This can be framed in a more scientific approach as a case study (like this article) or in a more informal manner, such as a blog post or postmortem. These formats have in common the documentation of why the team made certain decisions, and which accessibility and inclusive features were prioritized at that time. This documentation serves as a valuable exercise for the team to reflect on their practices and can be used as guidance for future projects. For this study, the research team documented the process as it was happening and reviewed things with the team.

5. Discussion

Designing with accessibility in mind from the beginning is the best approach [1, 20, 21, 22]. It allows the team to understand various users' needs, backgrounds, and identities, informing design decisions. This includes identifying and removing possible interaction barriers, creating more diverse game worlds, and better articulating educational goals based on learners' instructional needs [4,7,8,9]. However, we also see the benefits of *reviewing and redesigning old projects* for inclusivity. This is a valuable opportunity, especially when we understand design for inclusion as a learning process [11]. We do better when we know better. Revising old games allows teams to see their growth and improve their products, making them more inclusive. Also, the process of redesigning prompts reflections on inclusion and informs and shapes future design projects.

Redesigning past games enables teams to make improvements that were previously impossible due to budget, time constraints, or lack of knowledge and awareness of the need. However, it's crucial to focus on the project goal and prioritize changes; otherwise, the project might exceed its scope and funding. Games are complex interconnected systems, so even a simple gameplay change

can impact the entire gameplay and require other time-consuming and budget-consuming changes. Changes also necessitate more user-testing to refine the new approach.

The redesign of *Theme Park Kitchen* highlighted how a single design decision that is not inclusive can impact the entire game and exclude users from interacting with and enjoying the game. The old version of the game was entirely based on time pressure. This popular mechanic is inaccessible for players who need more time to process information and react as part of their cognitive needs [35]. When the team attempted to remove this mechanic from the game, they faced some challenges, as it had implications for the entire gameplay. This shows how important it is to design with accessibility in mind from the beginning of a design project. The lesson from this process was to strive to design games from the beginning to avoid time pressure, as we know this is a barrier for many users.

Another lesson from this project is to be sensitive to cultural appropriation in games. A theme is a big aspect of games; it shapes their tone and determines many gameplay elements. As part of game design, there is a level of creativity and exploration of ideas that is natural to the process. What also needs to become natural is to begin with research and cultivate understanding of cultures to ensure themes or game ideas are not offensive to some groups and do not superficially misrepresent groups and communities, especially marginalized or minoritized groups [2, 11, 13, 37]. It starts with the team acknowledging and addressing their biases and assumptions about the project, consulting and collaborating with the project audience, and conducting internal and external reviews of the project. When seeking ways to ensure inclusivity in the design process, conducting reviews at various stages proved to be a valuable practice. Whether conducted internally or externally, these reviews provide diverse perspectives and help the team identify and address biases and misconceptions about content and users at critical junctures.

It is important to understand the power of design. Designers create representations of society via different media and artifacts (e.g., games, animations, infographics), which can reinforce stereotypes and misrepresent groups and communities, especially minorities and marginalized groups [11]. It is the responsibility of design teams to consider how cultural stories, art, and historical characters are used and ensure that this type of design includes a deep understanding and representation and does not cause harm to groups and communities. This case study identified a five-step design process that can be used to redesign games towards accessibility and inclusion (figure 8):

1. **Use a framework for inclusive game design:** Whether from the literature or built for your team, a framework supports team discussion and guides design decisions toward accessible and inclusive design best practices.
2. **Identify key details specific to your game:** Every game is unique and presents its accessibility challenges. Understanding these challenges and finding ways to broaden the game's reach is essential to the development process. Playing the game and consulting with experts or players helps the team recognize what makes the game distinctive and assists in designing strategies to enhance accessibility.
3. **Resolve conflicting decisions:** Once accessible challenges are identified, the team needs to address the conflicting design decisions. This process requires time and extensive discussion. It is part of the beauty of design, and it is hard. For example, if the game is centered around a time pressure mechanic, how can the design make it fun and challenging while ensuring it remains accessible?
4. **Implement development with consistent review:** Even when decisions are made, the team needs to test and collect feedback from stakeholders regularly. The idea is to iterate on the design decisions as much as possible, refining the design solutions through internal and external reviews to enhance accessibility and the overall play experience.
5. **Document the process:** From the mindset that design is intentional, documenting decisions is a best practice for the team. This practice allows the team to reflect on projects to guide future work and enables sharing lessons learned with the game community. This

sharing can be done more formally, such as case studies, or in informal formats like blog posts, journals, and postmortems.

Figure 8. Redesign process for inclusive games.

The development studio that created this game is a non-profit team based at a Land-Grant University. We consider ourselves successful when more people use our educational media products and learn from them. When we receive funding to improve a successful project, we take the opportunity to make it more accessible and cover different needs. We understand that this may not align with the goals of other developers, particularly those in the industry with different agendas, metrics, and goals. In the larger industry, instead of a redesign, a new version of the game is often released with more accessibility features. For example, part two of *The Last of Us* came with many accessibility features. We understand that this process will need to be adapted to each development environment.

We recognize that this case study presents an insider's view of the re-designed product. To better understand the players' perspectives, our team is conducting a research study to assess the learning impact of *Theme Park Kitchen* and the overall user experience of the game for future studies. Additionally, as a limitation, this study represents the perspective of one team with a specific game; the process and recommendations articulated in this study may help other teams, but they may not cover team needs. For example, our team had been studying and getting training on accessibility for more than four years before the redesign process. Thus, the concepts and ideas around inclusive design were very familiar, valued, and clear to all team members (e.g., artists, developers, programmers, and researchers). This level of familiarity may not be the same as that of other development teams. Some teams may require extra steps for the process to work.

The redesign framework presented in this study has been successfully implemented by a small game development team, and it is likely to benefit other teams as well. However, the framework has not yet been validated with additional teams, and this effort represents a direction for future studies.

6. Conclusion

The study outlines the redesign process undertaken to make *Theme Park Kitchen* more inclusive and accessible. *Theme Park Kitchen* was launched in January 2024 and has been highly successful, with 154,243 plays, with weekly and monthly timing suggesting classroom use. Usage exceeds the average for educational games from this studio and shows an upward trend, with approximately ¼ occurring during the first year and ¾ during the second year since its release. To better inform the game's popularity, a second study measuring its impact on players' gameplay experience and food safety content learning is under review and will share data regarding the game's effectiveness. The redesign process provided valuable insights for the Learning Games Lab team. The purpose of this study is not to present a successful formula for designing inclusive games or to determine how teams should approach their processes. Instead, the intention is to foster discussion and present how one educational team addressed inclusion in their games. The case study presented here exemplifies how a team can improve their processes, intentionally change design decisions, create more inclusive games representing various backgrounds and perspectives, and support many needs.

The case study presented here highlights real-life examples of some of the challenges development teams face when designing for accessibility. For instance, some accessibility needs can be contradictory, and others may fall outside the project's budget or timeline. Consequently, the redesigned game is more accessible than before, but it does not achieve 100% accessibility; there are still barriers that the team will need to address in future projects. And with that, this study wants to normalize the notion that accessibility is a process rather than a perfect solution. Recognizing limitations and working intentionally on future projects is a crucial part of this ongoing process.

Limitations of this case study include that this is an educational game, tested with a small sample of players, and that we did not systematically test gameplay with players with specific disabilities. Although the team consults with players and organizations to determine which accommodations are most helpful, testing is conducted with volunteer groups of students from local populations. Outreach and recruitment for these testing sessions is directed towards all local students, with a variety of user needs.

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Conflicts of interest

There is no conflict of interest.

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