Accessible Design of Serious Games for People with Intellectual Disabilities in Inclusive Vocational Education

Victoria Batz
Magdeburg-Stendal University of Applied Sciences
Breitscheidstraße 2
39114 Magdeburg
victoria.batz@h2.de

Inga Lipowski, Matthias Morfeld
Magdeburg-Stendal University of Applied Sciences
Breitscheidstraße 2
39114 Magdeburg
inga.lipowski@h2.de, matthias.morfeld@h2.de

Christian Hansen
Otto von Guericke University Magdeburg
Otto-Hahn-Straße 2
39106 Magdeburg
hansen@isg.cs.uni-magdeburg.de

Michael A. Herzog
Magdeburg-Stendal University of Applied Sciences
Breitscheidstraße 2
39114 Magdeburg
michael.herzog@h2.de

ABSTRACT
People with disabilities are often denied the opportunity to obtain a vocational qualification. There is a lack of an appropriate infrastructure for an inclusive education system and recognized degrees. Therefore, didactic methods for inclusive learning situations are needed. This paper describes the user-centered development and evaluation of a serious game for inclusive vocational training in kitchen professions. The theoretical teaching content in the module "hygiene" is taught to people with and without cognitive impairments using a gamified learning application. The prototype was evaluated with 22 participants when used in an inclusive teaching setting with a mixed-methods design. The learning application caused an increase in motivation and the knowledge quiz achieved good results across all target groups (15 trainee cooks, 4 trainees as kitchen assistants, 3 employees of the sheltered workshop). The results from questioning, learning quiz, observation, and video analysis form design guidelines for future digital, interactive teaching methods for inclusive vocational education.

Keywords
Universal design, Technical-Enhanced Learning, Inclusive vocational training, High-fidelity prototyping, Serious Games, Gamification for people with intellectual disabilities

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1. INTRODUCTION

This investigation explores the potential effects of serious games (SGs) as a digital teaching method for inclusive vocational education in a German school setting. The German educational system is characterized by segregated learning according to personal abilities and learning results, with clear separation of people with disabilities. Although the global commitment "Education for All" led by UNESCO (Degener 2015), the Convention on the Rights of Persons with Disabilities of the United Nations, and the Federal Participation Act (Schubert et al. 2016) have politically strengthened the equal participation and self-determination of people with disabilities in the areas of education and work in Germany since 2009, inclusion is often not implemented in society as required. Inclusion promotes a diversity-driven understanding of educational, working and living environments. Currently, there are very limited vocational and training opportunities for people with intellectual, mental, and severe physical disabilities. An intellectual disability refers to the limitation of a person's cognitive abilities and social adaptability. The causes and symptoms of an intellectual disability can be very different. They can be caused by organic factors as well as psychological effects or environmental influences (Spreen 2013). Mental disabilities may be accompanied by characteristic expressions of emotion, sensory defects, individual development pace, behavioral challenges such as mild irritability, lethargy, or lack of self-control. Learning can be particularly challenging due to concentration difficulties, hyperactivity and impaired memory (Stöppler 2017). Sheltered workshops for people with disabilities provide integration measures but often do not offer the individuals concerned the opportunity to acquire a certified qualification that enables them to work in the general labor market (Gillen et al. 2017). Inclusion aims to offer suitable alternatives to employment in a sheltered workshop according to personal abilities. Therefore, special institutions for people with disabilities need to be transformed.

In an inclusive training program, trainees with and without learning disabilities are required to complete the theoretical part of their vocational training together in one classroom so that everyone receives certification according to their competencies. Therefore, three different training paths are merged: regular cook training, rehabilitation training to become a kitchen assistant, and practical training without a certification for people with intellectual disabilities (PID) who work in the kitchen area in sheltered workshops. The three-year dual training system to become a cook in Germany comprises theory taught at vocational schools and practical training in training companies. The three-year dual vocational training program for kitchen assistants is aimed at people with learning disabilities and special support needs. Theory knowledge is reduced in the rehabilitation training program because the trainees often have learning disabilities such as dyslexia or dyscalculia and a general lack of concentration (Tischler 2019; Koßmann 2019). The educational institution supports trainees to become kitchen assistants through special tutoring in theory and practice, preparation for exams, and pedagogical or psychological support (Dörner et al. 2018).

Different fields, such as education, have successfully used SGs and entertainment games for "serious" purposes for various target audiences (Tsikinas et al. 2018). Nevertheless, Hersh and Leporini (2018) have identified a lack of games for vocational education and SGs that user groups can use with or without different impairments. Games, and SGs in particular, are generally developed for a non-disabled audience rather than pursuing a "design for all" approach to make the game playable and enjoyable for the most diverse population possible (Hersh et al. 2018). In this work, we explore the potential effects of SGs as a digital teaching method for inclusive vocational education in kitchen professions. The use of digital tools offers the possibility of preparing the learning content individually for the target groups' different learning

requirements and abilities. For this purpose, an interactive point-and-click adventure was developed and evaluated in an inclusive vocational education setting. As few studies involve the target group - people with cognitive impairments - in user testing (Hersh et al. 2018), here they are involved in the design process from the very beginning. In terms of content, the SG teaches hygiene rules in the kitchen, and the module is part of the regular cook training curriculum. The effect of the digital learning application in inclusive education is examined from the following points of view:

- Can teachers and learners benefit from the use of digital game-based learning (e.g., serious games) to implement inclusive education?
- How can serious games for inclusive education be designed to reduce barriers for people with intellectual disabilities and/or learning difficulties to work with digital media?
- Can trainee cooks, kitchen assistants, and people with intellectual disabilities handle the same amount of teaching material in the same amount of time?
- What are the framework conditions for using digital assistance systems in inclusive vocational education?

Furthermore, we examine the extent to which the use of SG for digital devices in the classroom and as learning support enhances the digital competence of people with cognitive impairments or disabilities.

2. SERIOUS GAMES FOR PEOPLE WITH DISABILITIES

2.1 State of the research

Digital games have the potential to create a safe, unbiased testing environment for people with disabilities. Learners can explore the virtual environment at their own pace. By individualizing the teaching content, optimal conditions can be created for the student's own learning process. This leads to increased motivation for learning (von der Groeben 2008). Game-like experiences improve reaction time, independent decision-making, and memory performance in people with intellectual disabilities (Lanyi et al. 2012). Game-based learning can be implemented through different approaches such as gamification, digital game-based learning, and serious games (SGs). American educational scientist Marc Prensky defines any combination of computer games and learning content (knowledge) as digital game-based learning (Prensky et al. 2003). Game elements (including game ideas, game rules, quests, etc.) place the student in a specific learning setting. By "experiencing and exploring" the course material, it becomes easier to memorize the content (Albrecht et al. 2016). While gamification describes the use of game elements and game principles in a non-game context, serious games are an entire learning application. In addition to playful entertainment, they have the clear intention of teaching the player something (Deterding et al. 2011).

Media educational specialist Christa Gebel proved empirically that digital game-based learning promotes cognitive, social, and personality-related skills, as well as media competence and sensory-motor skills (Albrecht et al. 2016). Sociologist Roger Caillois emphasizes the goal-oriented nature of digital games (Caillois 2017). They create an initial situation that can be repeated infinite times. The player competes with him/herself and thus enables successive progress in the exercise situation (Neitzel 1998). Serious games in the form of a point-and-click-adventure are the link between knowledge and practice. They offer an opportunity for players to test their own abilities. Delivering learning content through SGs can help learners acquire knowledge through experience. Feedback provides players with information about their individual learning progress (Darling-Hammond et al. 2020). Mistakes are not to be avoided but are even

desired. Users find the right solution themselves via trial and error. They are the center of attention and learn at their own pace without external pressure. The results of a point-and-click-adventure reflect only personal progress, without the player having to compete with "better" or "worse" performances (Gregory et al. 2016).

When the accessibility and usability of games for people with disabilities have been considered, it has usually been for a specific group of disabled people, such as the blind or deaf (Hersh et al. 2018). According to a study by Tsikinias et al. (2016) there is a limited selection of SGs for teaching practical skills or theoretical content to young adults with intellectual disabilities. The majority have been developed for people with autism spectrum disorder rather than people with intellectual disabilities. These games mainly aim to improve interpersonal social interaction. Most of these SGs are either desktop or app-based and are more likely to be designed for the PC than for mobile devices (tablet or smartphone); therefore, they miss out on the benefits of multi-touch displays (Tsikinas et al. 2016). To date, there are no web-based applications for mobile devices (Tsikinas et al. 2017); these would, however, have the advantage of a location and time-independent, freely accessible distribution of the game. The results show that SGs are more suitable for teaching theoretical content and abstract concepts in a role-playing scenario (Tsikinas et al. 2016).

Promising results were obtained by Ana Rus Cano et al. (2018) with the point-and-click adventure *Downtown*, which teaches mentally disabled adults how to travel independently around the city of Madrid using public transportation. Overall, navigational proficiency improved, error rates decreased, and almost all students could complete at least one route without error (Cano et al. 2018). Since PID often lack spatial skills, Brown et al. (2013) also developed a SG for the target group to improve navigational skills such as following the instructions of route guiding systems (Brown et al. 2013). *Recall* explains the route by means of a storyline. The evaluation of the app revealed a correlation between user satisfaction and prior technological knowledge. When faced with technical problems was higher due to previous personal experience. Confidence in using the digital application increased with experience, and the stress level decreased (Brown et al. 2013). Thorkild Hanghøj et al. (2018) have examined whether the use of cooperative SGs in lower secondary education with students who show behavioral problems and low learning participation leads to more motivation and inclusion in heterogeneous classrooms. Students confirmed that they felt more comfortable and motivated and less under pressure when learning (Hanghøj et al. 2018).

The game *My First Day at Work* (eAdventures 2012) supports PID as they enter the job market. During the game evaluation, it was observed that participants with severe intellectual disabilities had problems remembering which tasks they had already solved. In contrast, participants with mild to moderate intellectual disabilities did not need further guidance (Ortiz et al. 2013). Abstract representations and stories in SGs are challenging for PID to understand. *The Big Party* (eAdventures 2012) helps young adults with intellectual disabilities get ready for a social evening in a professional environment (Ortiz et al. 2013). The game was tested in two Living Labs with teachers and students with Down's syndrome. It turned out that some users had difficulties identifying with the avatar and therefore did not understand the tasks. That is why games like *My First Day at Work* and *The Big Party* are designed with photos and videos of natural environments or cartoon-like scenes.

2.2 Design guidelines and principles

Designing serious games that are entertaining, exciting, and successful in supporting learning is a complex task. When designing educational games for PID, certain requirements regarding accessibility and media competence must be considered

additionally (Rosenstingl et al. 2010). Several design principles and frameworks have already been proposed in various publications (Hersh et al. 2018). However, they are not necessarily fully inclusive. Instead, they follow an individualized approach that takes the different needs of the users into account (Torrente et al. 2012). A selection of design principles for the design of SGs for PID, which can be derived from the current literature, has been compiled in the following categories: Graphical User Interface, Game Difficulty, Customization, Feedback, and Monitoring.

Graphical User Interface: Jaramillo-Alcázar et al. (2018) identified the use of Plain Language, subtitles for voice output, and simple but direct speech as elementary parameters for designing inclusive user-centered interfaces for mobile devices. To prevent monotony or to achieve better results cooperatively, a multiplayer mode can be added (Cairns et al. 2019). The operation of game elements should be as simple as possible and therefore contain a minimum of different interactions. In addition, the player should be distracted as little as possible from the primary task. A clear and simple graphical interface with engaging game elements contributes to this, as does the absence of distracting backgrounds, sound effects, and disturbing animations. However, embedded sound effects emphasize game decisions and can prevent incorrect gameplay (Boleracki et al. 2015).

Game Difficulty: To achieve engagement and immersion in games for PID, researchers have stressed the importance of a gradual increase in in-game difficulty based on players' performance (Bottino et al. 2014). By differentiating the learning objectives in the game, a comfortable level of performance is established for each user. Learning should take place almost casually while playing (Priebatsch 2010). One of the most critical features of games is adjusting the difficulty, duration, and speed of the game to the user's abilities to avoid feelings of anxiety, failure, boredom, and stress. Many games require a quick response, which is a barrier for PID. However, slowing the game down could make it less interesting and exciting for trainees without learning disabilities (Hersh et al. 2018). Player support also includes an in-game tutorial or a sandbox mode as an entry point before the game starts (Jaramillo-Alcázar et al. 2018). Audio-visual support mechanisms and help features like context-aware cues and options to choose assistance to continue playing, a reminder of control elements and game rules, save game state, the possibility of replay, pause for reading text overlays, input aids such as voice or gesture control, and a sleep mode to retreat when overwhelmed make games more accessible for PID (Hersh et al. 2018).

Customization: The 22 design principles of the Able Gamers Foundation include the selection of different output variants of information, for example, through visual, haptic, and/or acoustic feedback (Cairns et al. 2019). Players can choose their own input methods and device. A mouse, pen, touchpad, console, or similar. The user interface can be changed in structure, contrast, proportions, and amount of content. In addition, individual elements can be highlighted, for example, by zooming in and out (Cairns et al. 2019). Adjustable error tolerance and the reduction or skipping of tasks lead to less frustration and seamless difficulty (Jaramillo-Alcázar et al. 2018).

Feedback: Textual, verbal, or visual feedback is essential in serious games for PID because it helps players assess their effort (Tsikinas et al. 2018). In SGs, feedback can be communicated as praise, progress indicators, points, rewards, confirmation, or visual highlight. The feedback should be positive rather than negative to encourage the player to retry and remain engaged (Tsikinas et al. 2018).

Monitoring: The learning process can be targeted by educators through analytics, exams, and observations. By implementing a telemonitoring tool, educators can assist learners by steering them in the right direction. Enabling educators to identify problems

in the learning process, such as undesirable gameplay or increased complexity, can improve the gaming experience and lead to important insights for the design of digital learning applications (Cano et al. 2018).

3. PROTOTYPE

3.1 Design process

To explore design principles for the development of accessible serious games in inclusive vocational training, a design science research process according to Peffers et al. (2007) was applied for this study. The concept for the game was developed using a user-centered design approach, which includes the active participation of the target groups and experts for a clear understanding of user requirements as well as the examination of current teaching methods and the use of media at vocational schools (Vredenburg et al. 2002). For the selection of barrier-free hardware, both observations and an unstructured practical test were conducted in the sheltered workshop and a vocational school, where the trainees used different devices and input methods (computer, smartphone, tablet, keyboard, mouse, mousepad, touchscreen, and smartpen). Tablets proved to be an accessible medium for all user groups and can be operated individually with different input methods (Lipowski 2020). To sketch out the game structure, the researchers created wireframes that were discussed and adapted with the vocational schoolteachers and a special needs teacher. The graphical user interface of the virtual kitchen was created based on the wireframes. Researchers received feedback on conceptual prototypes, enabling them to collect information on educational preferences and identify possible issues. The close coordination and joint decisions during the design process with special educators, teachers, psychologists, and cooking trainers enabled the consideration of pedagogical, psychological, design, and professional perspectives. The game was prototypically implemented with the user experience software Axure RP Pro, a multifunctional tool specialized in creating web, mobile, and desktop applications. All participants used a Surface Go tablet for the inclusive lessons (Fig. 1). The game was realized as a web app with a responsive interface design. Vector graphics illustrations, created with the editor Sketch, were imported into Axure via a plug-in.

Figure 1: Axure prototype on Surface Go tablet

3.2 Content and concept

For digital intervention in inclusive vocational school teaching, suitable learning content was selected and prepared with a special education teacher from the vocational training area of the sheltered workshop, a rehabilitation psychologist, two vocational school teachers, a chef trainer, and an interaction designer. The teaching content was modularized by taking inclusive didactic methods into account and differentiating the amount of content. The module “Hygiene” covers topics such as the definition of hygiene, modes of transmission, microorganisms, hygiene in the kitchen, and types of spoilage. The hygiene rules and hygiene measures are particularly suitable for teaching in the context of inclusive education as all test groups have a practical connection to

the topic. The rules are divided into three hygiene areas: personal hygiene, kitchen hygiene, and product hygiene. The hygiene game simulates the routines of a professional cook, and the avatar passes through three rooms in which numerous hygiene mistakes are hidden (Fig. 2).

Figure 2: Changing room, kitchen, and food storage

First, the virtual chef gets ready for work in the locker room and considers the rules of personal hygiene: changing clothes, cleaning, and disinfecting. When all precautions have been taken, and all points have been collected, the avatar enters the kitchen. This room hides industrial hygiene mistakes: dirty dishes, foreign objects, garbage, the wrong temperature in the refrigerator. Finally, the avatar checks the warehouse, where the fish must be cleaned of defrosted water and the shelves of pests so that product hygiene is maintained. The concept is based on the principle of a point-and-click adventure implemented as a SG. Integrating educational content into a narrative flow (storytelling) gives an incentive to discover hidden clues. The task to be solved (quest) – finding all hygiene mistakes in the kitchen area – in combination with game elements is designed to hold the attention until the end of the game.

3.3 Game design

The design, play, and experience (DPE) framework by Brian M. Winn (2009), shown in Fig. 3, was developed to optimize the learning process in serious games by breaking down the game experience into four main components: the learning layer, the storytelling layer, the gameplay layer, and the user experience layer. The main features of the DPE framework apply to the design of the hygiene game as follows:

Figure 3: DPE framework based on Winn (2009)

Learning layer

The learning layer defines the intended learning goal, the teaching content, and the pedagogical methods used to convey the learning material. Learning success can only be achieved if the game is an integral part of the curriculum. After a brief theoretical introduction to the topic hygiene, all trainees practically apply the hygiene rules in the virtual kitchen. The exercise is followed by additional tasks on the tablet with reference to the learning game. In groups, the trainees consider further hygiene rules and transfer

them to other contexts. The game is designed based on the first three levels of Bloom's Taxonomy outcomes: knowledge, comprehension, and application (Armstrong 2016).

Storytelling layer

The motivation to play and stay engaged depends on the quality of the game design. Game attributes like the avatar, storytelling, the environment, animations, sound design, and decision-making enhance the immersive experience for the player (Winn 2009). The avatar was chosen to appear gender-neutral to appeal to a heterogeneous group of users. Correct decisions are supported by sound effects. Successful achievements, such as opening the door to the next room (level), are also accompanied by an acoustic signal. Wrong decisions are not highlighted in this version of the game.

Gameplay layer

Gameplay includes game mechanics and dynamics like allowed actions, rules, interactions, immersion, problem solving, competition, feedback, and communication in general. The gameplay should balance the difficulty level according to individual skills and reflect the player's own performance (Winn 2009). Direct feedback can help learners reflect on their actions. As a result, learning behavior can be self-regulated and improved (Nguyen et al. 2018). The objective of the hygiene game is to collect points for fixed defects. With each fixed mistake, the avatar moves one step across the room towards the next door. The error counter serves as a progress indicator. The two levels of difficulty of the hygiene game differ according to two main factors – feedback and error tolerance. Advanced users can enter the next room only after achieving the full score. The player can enter the next level without finding all the hidden mistakes in the easier version. Confident players receive visual feedback when they have identified an error correctly, but there is no explicit explanation of the hygiene rule. The error is fixed automatically by showing an animation. For players with more need of support, the hygiene rules are described in a lightbox (Fig. 4).

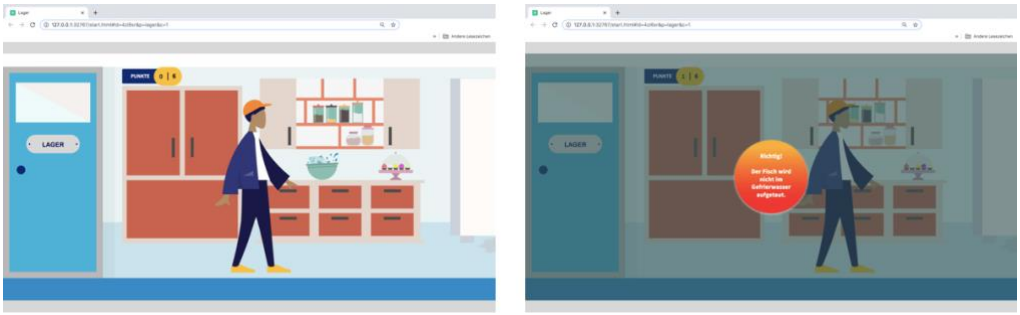

Figure 4: Highlighted feedback on hygiene rules

User experience layer

A low-barrier user interface increases fun and concentration. Technical problems quickly lead to frustration and distract from the learning task (Winn 2009). In addition to a bright and clearly arranged user interface, the game can be operated with the keyboard, a mouse, a touchpad, directly on the touchscreen, or a smartpen. Speech input could not be prototyped for the required needs of the target groups. To reduce complexity, interaction was limited to one input gesture. Hygiene errors are identified and corrected by clicking on certain elements in the game.

4. EVALUATION

4.1 Setting

The hygiene module was taught in three consecutive lessons of 135 minutes each at a vocational school by two teachers who had previously received training on digitalization and inclusion. The teachers were supported by a social pedagogue and a staff member from the vocational school to design accessible learning materials and lesson preparation. A touch board and tablets with keyboard, mouse, and headphones were purchased for inclusive lessons. The inclusive class was conducted with 22 participants between 16 and 35 years (Fig. 5). All participants had a personal tablet at their disposal. Seven participants had graduated from a special school or had not graduated from school. The sample consists of three test groups: 15 trainee cooks (1st year apprentices to become a cook, restaurant manager, or specialist in the hospitality industry), 4 trainee as kitchen assistants (1st year apprentices to become kitchen assistants) and 3 employees of the sheltered workshop (kitchen area). The participants in this study were not asked to state a disability, as this does not correspond to the inclusion setting. It can be assumed that trainee as kitchen assistants as well as the employees of the sheltered workshop probably have a learning disability or cognitive impairment.

Figure 5: Participants performing the hygiene game

4.2 Methods

A mixed-methods design was used to evaluate the study (Kuckartz 2014). Quantitative (questionnaire and online survey) and qualitative research methods (classroom observation and video analysis) were conducted simultaneously. The advantages of both approaches complement each other – representative data are generated, and detailed information about classroom learning is collected. The participants were given detailed information about the aim and purpose of the study. The SG is part of the mandatory vocational school curriculum. Trainees and employees could participate voluntarily in the questionnaire and the online survey. Two test supervisors and three teachers supported the surveys with participants with special needs. If participants had reading difficulties or comprehension problems, the text was read aloud or explained as needed.

4.3 Questionnaire

A questionnaire was created in cooperation with teachers to find out how much relevant information can be retrieved by the test subjects after they have played the learning game once. The participants completed the questionnaire with open and multiple-choice questions at the end of the lesson. The 16 items consist of knowledge queries

and open feedback on the educational game. In addition, the test group and the selected version of the game were registered. The answers to the quiz (attention and knowledge questions) were scored to obtain a scale for all correct and incorrect answers for each participant. One point was awarded for each correct answer, which meant that a maximum of 22 points could be achieved.

4.4 Online survey

Despite extensive research, no suitable questionnaire could be identified for the two aspects of digitization and inclusion (Batz et al. 2021). Therefore, an online questionnaire was developed by the multiprofessional research team. One week after the SG was used in class the online survey was conducted with the participants via SoSci Survey on the aspects of inclusion and digitization in the classroom. Five questions related to using digital tools (tablet, touchboard, serious game) in the classroom. On a scale of 1 (do not agree at all) to 6 (totally agree) participants were asked to rate how they got along with the media, whether the application facilitated learning, to what extent they would also use the digital tools outside of class, and what effect the digital learning application had on motivation and fun while learning.

4.5 Observation

While the learning game was being used in class, two researchers conducted and recorded non-participatory, open, and unstructured observations. The exploratory approach was chosen to gain a comprehensive insight into inclusive education and consider all positive and negative aspects. The evaluation was carried out with the help of qualitative content analysis in the following nine categories: game duration, technical problems, interactions within the game, digital media in the classroom, peer learning, well-being of the participants from the sheltered workshop, social and digital competence, and the general course of instruction.

4.6 Video analysis

A volunteer participant from the sheltered workshop was filmed while playing the SG. The aim of the analysis was to obtain important information for the target group PID, which could not be obtained through a questionnaire. The video material (approx. 38 minutes) was evaluated with qualitative content analysis. The focus was on analyzing how the participant performed in the learning game, what emotions and reactions he showed, and what problems arose. For this purpose, the following categories were determined for the observation: a short description of the scenery, emotions (facial expressions, gestures, verbal expressions), digital interaction, learning process/help, and occurring problems. A total of 11 scenes were defined based on content, each lasting approximately 1 to 4.5 minutes.

5. RESULTS

5.1 Questionnaire

All 22 participants completed the questionnaire right after using the hygiene game. Around 43% chose the medium version, and 57% chose the easier version with more feedback and higher error tolerance. Eight cooks and one kitchen assistant chose the version with less error tolerance and less feedback on the teaching content. The easier version was used by six cooks, three kitchen assistants, and three sheltered workshop employees.

On average, each participant scored 20.5 points (M=20.45; SD=0.96) and made 1.6 errors (M=1.55; SD=0.96) on the quiz. This ranged from 19 to 22 points and zero to three errors. Three people answered all questions correctly, and 19 respondents had at least one error. Regarding the number of correct answers and mistakes, there were no significant differences between the results of the test groups cooks (M=20.60;

SD=0.91), kitchen assistants (*M*=20.00; *SD*=1.16), and employees of sheltered workshops (*M*=20.33; *SD*=1.16). Figure 6 shows the distribution of the scores achieved in each of the three test groups in absolute frequency. Figures 7 and 8 show the mean values of scores achieved and the number of mistakes made separated by test groups. It can be seen that although three cooks achieved the maximum score of 22 points, the mean of points achieved and mistakes do not differ significantly between the three groups. The T-tests for independent samples between the three test groups also revealed no significant mean differences in the number of correct answers and mistakes.

Figure 6: Number of people with 19 to 22 points achieved in quiz separated by test groups

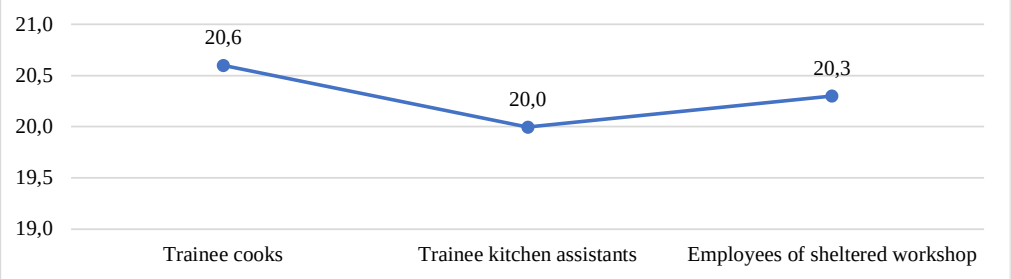

Figure 7: Mean of correct answers (points) separated by test group

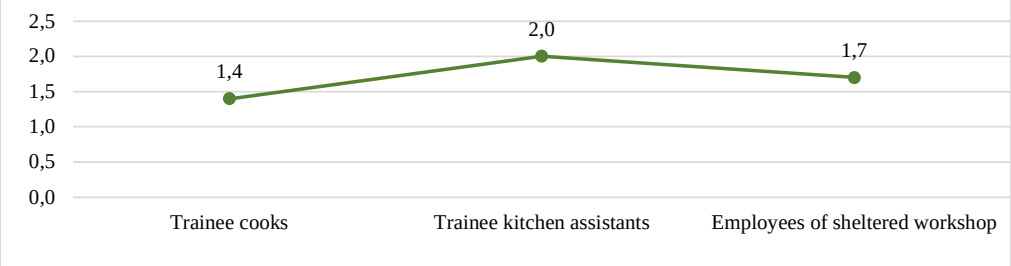

Figure 8: Mean of mistakes made in the quiz separated by test group

14 participants stated that they had fun using the serious game and approved this type of learning method. Three respondents had less fun with the game and expressed criticism. Another three participants liked the game and made suggestions for improvement. The most frequent criticisms were that it was too simple, followed by too boring, and the interface appeals more to children. In addition, some of the hygiene errors were difficult to recognize. The majority emphasized the good learning effect, followed by the entertainment value, the demanding level, the possibility of repetition, and the design of the animation. Thirteen respondents highlighted specific aspects of the game that they liked in particular. Five participants mentioned the user experience, such as the simple click interaction and the user interface. Others highlighted positive aspects of digital game-based learning as a teaching method, the level of challenge, and the optimal game length. Three people would like to improve the game with a different graphical representation of the kitchen, followed by a zoom function and hygiene errors that are easier to recognize. Two participants would like to use another version of the game with more difficulty. Other suggestions from individual participants included more hints when needed, a more detailed explanation of hygiene rules, more rooms (level) to play in, integrating more tasks and in-between questions into the game, and better internet on site.

5.2 Online survey

At the end of the module on hygiene, 16 participants completed the online questionnaire. Table 1 shows the descriptive statistics of the five items. Participants indicated that they felt very confident using the digital tools (*M*=5.63; *SD*=0.72). 75% of the survey group are very comfortable with the technology, and 25% are comfortable or quite comfortable. The majority (87.5%) confirm that digital tools make learning significantly easier (*M*=4.88; *SD*=1.36). About 12.5% cannot identify any improved learning effect. Digital devices are mainly used at home or work (*M*=4.00; *SD*=1.46). The majority (75%) use media quite often up to very often, but 25% do not use digital hardware and software at all or rather rarely for studying purposes. Nevertheless, the participants perceive the digital tools as a major motivating factor in the classroom (*M*=5.06; *SD*=1.00). The digital tools have been shown to increase the pleasure of learning (*M*=5.25, *SD*=1.00). Only one person (6.3%) does not confirm that the digital tools make learning more fun.

Items	**M**	**SD**	**Percentage frequency in %**					
			1	2	3	4	5	6
I get along well with the digital tools.	5.63	0.72	0	0	0	12.5	12.5	75.0
The digital tools make learning easier for me.	4.88	1.36	6.3	0	6.3	12.5	37.5	37.5
I also use digital tools at home or work.	4.00	1.46	6.3	12.5	6.3	43.8	12.5	18.8
The digital tools motivate me in class.	5.06	1.00	0	0	6.3	25.0	25.0	43.8
The digital tools make learning more fun.	5.25	1.00	0	0	6.3	18.8	18.8	56.3

Table 1: Statistics of the five digitization items with *N*=16. N=number; M=mean; SD=standard deviation; Scale 1= “do not agree at all” to 6 = “totally agree”

5.3 Observation

By evaluating the observations, the differences in learning speed and game duration become apparent. The first participants finished the game after about 15 minutes, and the last ones finished after about 33 minutes. Some students intentionally tried to find all the mistakes as fast as possible. They wanted to set a record. Having to wait afterward resulted in boredom. Some technical errors occasionally occurred when using the prototype. Horizontal scrolling and clicking on the touchscreen caused difficulties for some participants. Due to interruptions in the internet connection, the web application had to be reloaded in some cases. The technical problems led to frustration among some participants. For non-German speaking participants, both the introductory text and the explanation of the hygiene rules in German were a challenge. Technical terms, in particular, were difficult to understand. If the participants did not recognize any further hygiene mistakes, some players tried to select the correct objects through trial and error. When randomly clicking on the correct hygiene rules, the lightbox appeared and was accidentally confirmed immediately, so it disappeared. It lacked the essential feedback to ensure that the student understood and memorized the content. By using the tablets, the sheltered workshop participants were able to take part in the lessons at their own pace. All of them chose the easier version of the hygiene game. The three participants worked at different speeds, but everyone needed personal assistance with tablet or game operations from time to time. During the break, some participants played the hygiene game again voluntarily.

5.4 Video analysis

The observed reactions of the participant changed noticeably during the game. In the beginning, uncertainty and impatience dominated, turning into concentration, motivation, and curiosity as the game progressed. The more experienced the participant became at playing the game, the more often he showed joy, self-confidence, and pride. After completing the game, the participant appeared bored because he had to wait for his classmates to finish. Due to the poor internet connection, loading pauses occurred during the game. In addition, longer sections of text caused the participant some difficulties. He read the explanations of the hygiene mistakes in the lightboxes aloud to himself for better understanding. In the beginning, the special education teacher explained the task and how the game worked on the tablet. The participant worked independently and asked for help when he got stuck. During the game, a personal tutor sat next to the participant and offered explanations and support if needed. In the middle of the game, the participant switched from using the smart pen to clicking with his finger on the touchscreen. Difficulties were observed with scrolling and clicking on the mistakes correctly.

6. DISCUSSION

6.1 Interpretation

The challenge of inclusive education is teaching the same learning content in the same processing time to target groups with different learning requirements and abilities. The serious game (SG) involved a playful and exciting examination of the topic "hygiene". The positive learning outcomes were most likely achieved by switching from traditional lecturing to exciting content delivery through an interactive game scenario. The observed differences between the participants were mainly evident in the handling of digital devices (hardware and software) and the processing time in which the tasks were completed in the game. A lack of digital competency on the part of the teaching staff and the participants makes the use of technical assistance in classrooms difficult and requires additional guidance and training. The employees of the sheltered workshop are not used to using tablets. Therefore, touch gestures are uncertain and not very accurate. The preparation and follow-up for the use of the tablets were particularly

time-consuming. This could be counteracted either by a “bring your own device” concept or personalized loan devices.

Some participants find the game too easy and too short; others find the tasks challenging and the game duration appropriate. Therefore, some participants finish sooner and have to wait to continue. These results indicate that an inclusive SG should have more game modes to meet all requirements, help balance processing time and avoid under- or overstraining. However, the fact that the participants themselves can choose the game's speed facilitates the learning process overall. Differentiation must take place on several levels. In addition to error tolerance and feedback, the content density and difficulty level should vary more. The test scenario lacked an “Advanced” version of the game with more tasks, longer gameplay due to bonus levels, intermediate questions, a combination of elements, hidden clues, and puzzles. An increase in performance could also be implemented via repetition as a multiplayer game with competitive parameters. This way, virtual peer learning is implemented. Cooperation with other students can increase teamwork across target groups (for example, exchanging things from one’s suitcase). Learning applications should not start in multiplayer mode by default to make it easier to get started. This prevents stigmatization based on different performance.

The majority of the subjects perceive the design of the hygiene game as appealing and easily accessible. The user test also documented important usability and accessibility weaknesses for PID and people with learning disabilities when using the digital learning application. The video analysis showed that the game introduction, in particular causes difficulties. Due to the limited development scope of the prototype, the game rules were described in text form before entry to the first level. Game introductions as text descriptions can be avoided with entry tutorials or a preview demonstrating basic interactions. In an educational context, information in text form is not always avoidable. Anyway, digital educational games have great potential to reduce the barriers faced by PID, for example, by creating game versions that are implemented either with speech input and audio output or text in so-called “simple language”. To improve the user experience scrolling through the virtual environment and focusing on objects are aspects that are still in need of optimization. Some participants expressed a desire for a zoom function. The personal support of trained professionals for PID is indispensable in the context of inclusive education. Employees of the sheltered workshop rely on the help of a special education teacher in addition to the use of digital learning tools. PID need continuous support in solving theoretical tasks.

6.2 Limitations

The participants came from different educational institutions and were specifically taught inclusively in the “Hygiene” module. That is why they have different experiences and initial conditions. The same applies to the teaching team, who have no special training in inclusive education. The use of new media for teaching and learning initially generates attention, interest, and concentration in the classroom. It is difficult to determine whether this effect will continue in the long term when digital applications and technical equipment become the standard in educational institutions (Breuer et al. 2019). Positive effects of SGs on test results and school grades have not yet been proven in long-term studies as well as the use of SGs for PID. Therefore, the positive effect of the SG can only be related to the positive results in this study. In addition, no reference group is taught inclusively under similar conditions without digital learning tools.

Evaluation with standardized test procedures can only be carried out to a limited extent. It is uncertain whether all participants fully understood the items of the questionnaires or if a self-assessment is feasible. No game-integrated analytics software was used for the evaluation of the educational game. SGs analytics for PID would improve

consideration of learners' accessibility needs and requirements. Pre-, in-game, and post analytics make it easier to reflect on whether learning objectives were met. In addition, the performance of all learners can be compared immediately. Tracking input information (clicks, touches, etc.) and comparing user profiles give learning game architects the ability to customize the learning process (Nguyen et al. 2018).

6.3 Suggestions for future research

Design principles and guidelines should be further explored to develop inclusive, accessible serious games and digital learning applications for the user groups PID and/or people with learning disabilities in general. Comprehensive design patterns and techniques are needed to make games fully accessible for the described context. The high cost of developing SGs for special education content must be reduced – for example, by developing platforms that facilitate the design of accessible games. Overall, few digital learning materials are available for teachers (Müller Werder et al. 2020). A digital exchange platform and toolkit for inclusive Open Education Resources (OER), where learning applications can be shared, adapted, or further developed, could be a solution. Learning materials should be usable by trainees and students at any time and in any location. There is an urgent need to be able to use digital devices such as tablets and user profiles independently of the educational institution. A personalized overview of achievements confirms personal progress.

In addition to the design guidelines, the framework conditions for digital assistance systems in inclusive vocational schools are also of fundamental importance. In order to avoid frustration and disappointment, the basic requirements for the use of digital media in inclusive education are consistently functioning systems and error-free applications. Therefore, the required digital equipment must be available in educational institutions, and compatibility with existing technologies and other devices is desirable. The conception and implementation of inclusive learning materials and digital applications require a considerable amount of additional work. The corresponding resources must be made available (personnel, financial, further training).

Attention and interest can be generated quite easily with digital games, whereas communicating knowledge is much more difficult (Breuer et al. 2019). SGs must be embedded in other learning activities as a conceptual supplement. The goal is not to present classic teaching methods (such as the classic lecture format) in new media or to offer digital games as a substitute for teaching. Games are more likely to contribute to learning success if they engage the user in their own context and inspire better skills. Teachers play an important role in adopting and effectively using a DGbL approach. They are the key players who can make the connection between games and curriculum (Arnab et al. 2013).

7. CONCLUSION

The research focus of this paper is on the design and evaluation of SGs as an inclusive teaching method for vocational education. Therefore, the theoretical knowledge from the module "hygiene" was implemented as an interactive point-and-click adventure. The SG was integrated into the curriculum in order to test and evaluate its effectiveness in an inclusive learning and teaching setting. In this pilot project, the three test groups of trainee cooks, trainee kitchen assistants, and employees from the kitchen area of the sheltered workshop – who were previously trained separately from each other – took part in the inclusive lessons together.

The hygiene game was developed to examine whether the use of SGs can support teachers and learners in implementing inclusive teaching approaches. The evaluation results show a positive response to digital educational games, even though using

screen-based media is challenging. In the online survey, the participants stated that they experienced a significant increase in motivation, easier learning through practical application of the content, and more fun in class. The results of the knowledge quiz show that the participants were able to answer the questions on hygiene rules very successfully across the test groups after using the game. Challenges can be identified in the low-barrier and inclusive design of digital applications. There is a lack of precise design guidelines for the user group of people with intellectual disabilities. The professional design and development of digital learning applications following a *design for all* approach enables inclusive learning conditions. This requires further research into guidelines for inclusive design. Inclusive learning materials should be made freely accessible to teachers and provide opportunities for customization.

SGs can teach theoretical knowledge in a playful way and address different cognitive abilities at the same time. However, SGs cannot implement and promote inclusion as a stand-alone method and align the learning progress of all trainees with different support needs. They should accompany inclusive education and be an integral part of the curriculum. For the implementation of inclusive vocational training, the appropriate framework conditions must be provided. The successful pedagogical use of digital devices and software in the classroom requires a certain level of digital competence on the part of learners and teachers, who must be trained accordingly.

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