EDeR

Educational Design Research

Volume 9 | Issue 2 | 2025 | Article 84

Contribution Academic Article

Title **Redesigning a Serious Game App with LESLLA Teachers for Adult Migrant Second Language and Literacy Learners: Enhancing Accessibility and Usability**

Author **Eva Malessa**
University of Jyväskylä
University of Turku
Finland

Abstract The lack of adequate digital learning material is a contentious issue in adult migrant literacy education. This study focused on enhancing a serious game's accessibility and usability for adult second language users with emergent literacy. Using a participatory design approach, teachers redesigned the *Lukukupla* literacy support app, developed for Finnish-speaking children, elaborating on potential barriers and redesign suggestions in game diaries and interviews. Motor skill and visibility were identified as crucial non-game-specific issues. Game-specific issues, including trauma insensitivity, were identified in learning content, instructions, feedback, visual and auditory input. Teachers' suggestions emphasized customization and vocabulary training to make the game more relevant and comprehensible for adults. These results highlight how digital learning environments are not automatically suitable for all literacy learners but need to be (re)designed to meet learners' needs. The article presents recommendations for the development of digital, target-group-specific learning environments for adult learners with limited formal education.

Keywords Mobile-assisted language learning (MALL), serious game, literacy education and second language learning for adults (LESLLA), participatory design with teachers, accessibility, usability.

DOI dx.doi.org/10.15460/eder.9.2.2348

Citation Malessa, E. (2025). Redesigning a Serious Game App with LESLLA Teachers for Adult Migrant Second Language and Literacy Learners: Enhancing Accessibility and Usability. *EDeR – Educational Design Research,* 9(2), 1-44.

dx.doi.org/10.15460/eder.9.2.2348

Redesigning a Serious Game App with LESLLA Teachers for Adult Migrant Second Language and Literacy Learners: Enhancing Accessibility and Usability

Eva Malessa

1.0 Introduction

1.1 Adult Migrant Language Learners Facing Late Literacy and Digital Challenges

Pressing global emergencies, including conflict, health and climate crises, have accelerated humanitarian migration to highly digital and literate countries. Sharing limited and/or interrupted formal education experiences, many refugee-background learners have only limited literacy skills in their home languages. In their new countries of residence, they become literacy education and second language learning for adults (LESLLA) learners and are confronted with the enormous challenge of orally acquiring a second language (L2) and simultaneously L2 literacy skills (Bigelow & Vinogradov, 2011). This double learning burden is further intensified by the need, brought on by the ubiquitous digitalization of daily life, to acquire digital skills (Rosen & Vanek, 2017). Learning to read and write for the first time as an adult in a L2 is a truly challenging endeavour. In comparison to L1 (first language) children, learners are at a clear disadvantage as they start to read and write without an extensive lexicon and have only emerging L2 phonological skills (Kurvers et al., 2010; Young-Scholten & Strom, 2006). External obstacles include the lack of sufficient instructional hours and individualized instruction (van de Craats & Young-Scholten, 2015). Many LESLLA learners struggle to meet digital (literacy) expectations. Therefore, relevant skill training must be incorporated in LESLLA education (Minuz & Kurvers, 2021; UNESCO, 2022).

Overall, access to effective and engaging learning opportunities and tools as well as the availability and accessibility of digital learning material can be major obstacles for LESLLA learners. I argue that meaningful and suitable technology-equipped (language) learning (TE(L)L) must be at the core of adult migrant basic education. I propose the term technology-equipped language learning (TELL), emphasizing the use of technology, instead of the traditionally used term technology-enhanced learning (TEL), which presumes a positive effect of technology (see Bayne, 2015). There is a need for target-group-specific design of digital learning materials for adult migrants with limited formal education experience to enhance educational technology's accessibility and usability for LESLLA learners.

Due to the lack of target-group-specific digital support tools, LESLLA teachers in Finland have reported using the *Ekapeli* [Firstgame] literacy

support game app with learners (Tammelin-Laine et al., 2020). However, both teachers and learners have called for a more appropriate, adult-focused and LESLLA-friendly game design (Malessa, 2023b). In this exploratory case study, in-service teachers with previous experience of using Ekapeli with their adult learners evaluated and redesigned the mobile, research-only *Lukukupla* [Reading bubble] literacy support game app. This non-commercial serious game is based on the long-standing, evidence-based research of the *GraphoLearn* digital game environment (see Borleffs et al., 2020; Ojanen et al., 2015; Puolakanaho & Latvala, 2017; Richardson & Lyytinen, 2014; Ronimus & Lyytinen, 2015). Educational learning games such as Ekapeli and Lukukupla are also known as serious games. Lukukupla was originally developed to support the initial reading development of L1 Finnish-speaking children, aged 7-8, during their first two school years. Lukukupla provides adaptive grapheme–phoneme correlation training embedded in an avatar fantasy world.

Focusing on the redesign of an existing mobile game app from the perspective of accessibility and usability, this study presents target-group-specific design guidelines that are applicable and transferable to other LESLLA-specific digital learning environments. This study also highlights the advantages of involving LESLLA teachers and benefiting from their experience and expertise in the development process of accessible, efficient, and enjoyable learning technology for a special learner population. LESLLA learners are also referred to as students with limited or interrupted formal education (SLIFE), particularly in North America (DeCapua, 2019; Pentón Herrera, 2022; Slaughter & Choi, 2024); however, I prefer the LESLLA acronym coined by the international LESLLA research community (see Malessa, 2023a).

1.2 Educational Technology for LESLLA Learners

LESLLA learners have traditionally been at the margins of mainstream research in education (Bigelow & Tarone, 2004; Malessa, 2023a; Young-Scholten, 2021), particularly in digital (literacy) learning contexts (Guichon, 2024; Malessa, 2018). This paucity of empirical research knowledge can partly be explained by researchers' focus on educated L2 learners and children. Literacy support game apps are almost entirely designed for primary school children mostly but not exclusively focusing on L1 literacy development (see Hautala et al., 2020; Holz et al., 2018; Reina-Reina et al., 2024). A welcome exception constitutes Woods et al.'s (2023) recent pilot study in the US involving adult multilingual learners testing a game app specifically designed for them. This single-case study provided promising results regarding the positive effects of game-based digital decoding training of common English words and highlights the potential of digital games as educational technology in L2 education (see Reinders, 2017; Sykes & Reinhardt, 2013; Westera, 2019) also for adult migrants with emerging L2 literacy skills.

While traditionally, the focus of LESLLA studies has been on print literacy skills, not digital learning (Kreeft Peyton & Young-Scholten, 2020; Tarone et al., 2009, 2013), previous studies with LESLLA learners have

revealed positive effects of individual computer-assisted language learning (CALL) activities (Kurvers et al., 2010; Strube, 2014). The Digital Literacy Instructor (DigLin) was one of the first online learning environments specifically designed for LESLLA learners (see Cucchiarini et al., 2013, 2015). DigLin provided phonics-based decoding skill practice in four alphabetic languages (Dutch, English, Finnish, German) and was field-tested with multilingual learners (Naeb & Sosiński, 2020). It was, however, not designed as a mobile application (see van de Craats & Young-Scholten, 2015), which limited its practice to classrooms where learners had access to computers.

Today, nearly all displaced persons are in possession of a mobile phone (Zelezny-Green et al., 2018) and have been identified as actively engaging in a diversity of smartphone practices (Kaufmann, 2018). Digital literacy practices of adult migrants including LESLLA learners in their new home countries have been attracting considerable research interest, e.g., in Australia (Tour et al., 2023), Italy (D'Agostino & Mocciaro, 2021), Finland (Eilola & Lilja, 2021), and Sweden (Norlund Shaswar, 2021). The widespread use and possession of mobile devices among displaced learners has led to a shift from computer-assisted to mobile-assisted language learning (MALL) contexts (Bradley & Al-Sabbagh, 2022) and an increase in learner-specific MALL applications targeted at newly arrived migrants (see Bradley et al., 2020; Drolia et al., 2022; Ngan et al., 2016). Mobile technology is vital for displaced learners to sustain communication with family and friends, yet particularly LESLLA learners need support in the use of computers and mobile devices as educational tools (Aberdeen, 2019; Malessa, 2023c). Furthermore, most MALL applications are not specifically targeted at LESLLA learners.

Educational technology research investigating adult migrant learners' digital language and literacy learning practices and possibilities has started to evolve during the last decade (Bradley et al., 2017), but a substantial dearth of research on LESLLA and refugee-background learners' TELL methods and practices remains (Gillespie, 2020; Naeb & Sosiński, 2020). This scarcity can partly be explained by the ethical and practical challenges resulting from LESLLA learners' research involvement (see Malessa, 2023a). Consequently, there is a lack of empirical evidence regarding the efficacy and enjoyment of digital (game-based) learning environments for LESLLA learners. The lack of robust evidence-based research is unfortunate, as LESLLA studies have indicated that learners' individualized computer practice may enhance both emerging alphabetic decoding and basic digital skills (Filimban, 2019; Malessa & Filimban, 2017). Serious games could be employed to deliver both decoding and digital skill training for LESLLA learners.

The unprecedented need for emergency remote learning caused by the recent Covid-19 pandemic demonstrated that not all adult migrant educators and educational facilities have been able to meet learners' digital tool and skill needs in pandemic times (Belzer et al., 2020; Lotas,

2021; Malessa, 2023c). Even though there is still a shortage of adequate learning material for LESLLA learners, the re-calibrated emphasis on learner-specific technology-equipped learning and teaching, particularly MALL obligations and opportunities, constitute the pandemic's silver lining (see Rillera Kempster, 2023). However, the lack of accessible learning material, adequate user skills, and device and internet availability remain practical issues for LESLLA education (Malessa, 2023c). Today's universal digitalization necessitates more research-based insights into relevant methods and innovations to enhance L2, literacy, and digital skill training of LESLLA learners (Malessa, 2021; Smyser, 2019).

1.3 Research Focus and Questions of the Presented Study

When redesigning specific learning material, in this case a serious game targeted at Finnish-speaking children, considering accessibility and usability for the intended target group is imperative to ensure access and enhance user experience for learners with significantly different capabilities and circumstances (see Cezarotto et al., 2022; Hersh & Leporini, 2014). This article adopts the ISO 9241 definition of usability as the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Standard Organization, 2010, cited in Hertzum, 2022, p. 9). The concept of accessibility is explored in relation to the teachers' perceptions of whether LESLLA learners can independently access the tested app's content. This study had two research questions: Based on their user experience of Lukukupla, what did the teachers report and propose regarding

- (RQ1) potential barriers limiting accessibility and usability for LESLLA learners, and
- (RQ2) prospective enablers and solutions to enhance accessibility and usability for LESLLA learners?

The first research question (RQ1) focused on teachers' individual gaming experience and evaluation of potential barriers restricting the accessibility and usability of Lukukupla. RQ2 investigated design solutions for enhancing accessibility and usability. The following section describes the design approach and methods used to answer this study's research questions.

2.0 Testing and Redesigning a Literacy Support App with LESLLA Teachers

A participatory design approach (see Robertson & Simonsen, 2013; Spinuzzi, 2005) was chosen for the redesign of Lukukupla. This exploratory case study adopted a slightly modified model: the use-oriented design cycle proposed by Bratteteig et al. (2013, p. 128). The current, independent design-based research (DBR) study is represented as sub-

study 2 (colour-coded in green in Figure 1 below) in the use-oriented design cycle. To establish an understanding of current teaching practices and to identify LESLLA stakeholders' requirements, the author conducted a first sub-study (Malessa, 2023c), colour-coded in orange in Figure 1 below. Contrary to Bratteteig's original model, the segments "evaluating" the existing learning game and "envisioning" solutions were conducted simultaneously, not consecutively. Furthermore, this study did not incorporate the task "materializing" of a prototype (colour-coded in grey in Figure 1 below). As developing and maintaining new learning games is a cost-intensive endeavour, requiring extensive human, time, and monetary resources (see Kuo & Chang, 2019), building a new game for LESLLA users was not a feasible alternative and requires a separate future study.

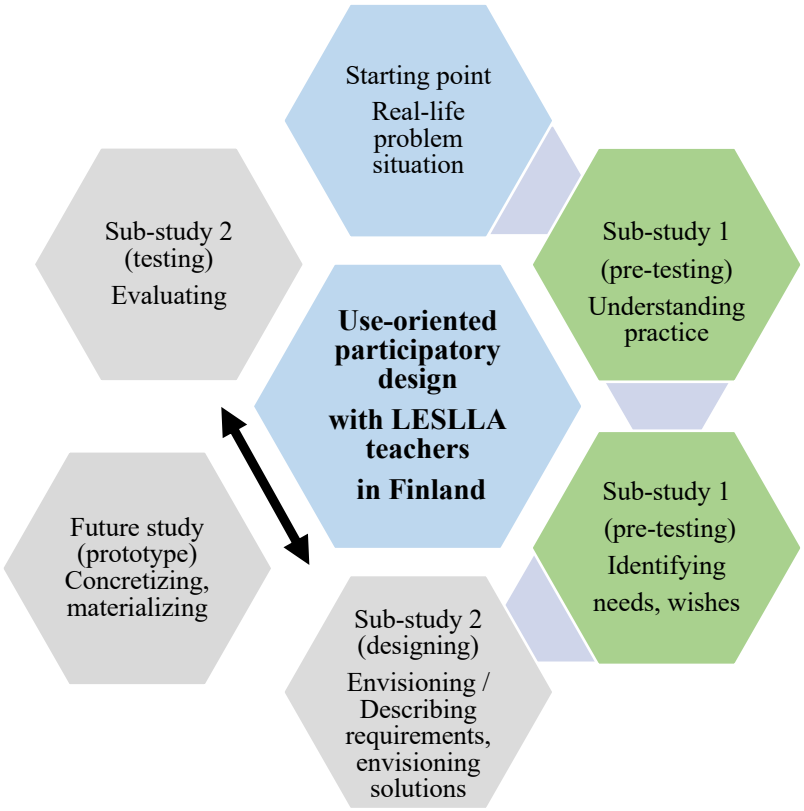

Figure 1*. Use-oriented Design Cycle employed in this Study (based on Bratteteig et al., 2013).*

Note. the arrow indicates that the "envisioning" and "evaluating" stages were conducted simultaneously.

Participatory design remains a relatively new approach in educational research (Cumbo & Selwyn, 2022), yet its inherently inclusive approach and practice is increasingly attracting research interest in educational studies (DiSalvo et al., 2017). The participatory design approach was considered to be particularly fruitful in this study to facilitate a learner-centred redesign of Lukukupla because it involved crucial participants in adult migrant education – teachers (Tuhkala, 2021). Teachers are indeed increasingly employed as collaborators in DBR (see Adams et al., 2020; Bogaerds-Hazenberg et al., 2019) and DBR has also gained impetus in language and literacy learning studies (see Dannecker et al., 2024; Delius, 2022; Drepper, 2024).

The study was carried out during the COVID-19 pandemic (November 2020 – May 2021) outside educational institutions in Finland (for an overview of how pandemic conditions impacted the development of this study see Malessa, 2023b). During the entirely remotely conducted testing phase, Talvi, Valo, and Havu (gender-neutral Finnish pseudonyms), in-service LESLLA teachers from the capital area around Helsinki, tested the Android-only Lukukupla app with their own mobile devices. Table 1 below presents the teacher-participants' diverse educational and professional backgrounds.

Table 1. *Teacher-participants' Background Information.*

	TALVI	VALO	HAVU
Learner group at time of participation	integration training, strengthening alphabetic skills module	adult basic education, literacy phase	adult basic education, literacy phase
Adult literacy teacher experience	3 years	1 year (15 years of primary school experience)	almost 10 years (not continuously)
Educational background	postgraduate degree (Finland), French language & literature (major subject), English / Finnish language & literature (minor subjects)	postgraduate degree (Finland)	postgraduate degree (Finland), English language & literature (major subject), Finnish language & literature (minor subject)
Teacher qualification	subject teacher qualification	primary school teacher qualification	n/a

Note. n/a = not applicable

Participants kept gaming diaries and discussed redesign solutions with the researcher-author during remotely conducted interviews, see Table 2 below. As teachers were testing the game under pandemic conditions, in their leisure time, it was decided not to control testing time, thereby allowing teachers to freely determine the intensity of their engagement with the research.

Table 2. *Data Production and Output.*

	TALVI	VALO	HAVU
Induction	Nov 2020	Nov 2020	Nov 2020
Interview 1	60 min	32 min	44 min
Evaluation 1	Dec 2020	Dec 2020	Dec 2020
Gaming diary 1	yes	yes	yes
Interview 2	73 min	58 min	58 min
Evaluation 2	Jan 2021	May 2021	Jan 2021
Gaming diary 2	yes	yes	yes
Interview 3	73 min	78 min	89 min
Evaluation 3	n/a	n/a	Mar 2021
Gaming diary 3	n/a	n/a	yes
Interview 4	n/a	n/a	65 min

Note. n/a = not applicable

Prior to the feedback interviews, teachers returned individual written gaming diaries, often containing screenshots. The diaries were based on a set of questions partly used in structuring the feedback interviews (see Appendix 1). Interviews (mean 63.5 min) were conducted via Zoom, recorded, and transcribed. For illustration purposes, screenshots of the video recordings were also added to the transcripts. Interview transcripts and gaming diaries were in Finnish; the researcher-author translated the excerpts. Examples were named after their source, i.e., Talvi (T), Valo (V), or Havu (H) and data type, i.e., gaming diary (gd), interview transcript (it): e.g., Tgd1 (Talvi's gaming diary 1).

Drawing on thematic analysis (Braun & Clarke, 2006), the data were analysed with the help of Atlas.ti. Data familiarisation started by transcribing interviews, re-watching them and coding transcripts iteratively based on the RQs. Themes and categories were inductively generated, yet partly also deductively grounded in the evaluation framework provided to teachers (see Appendix 1). Two separate codebooks for RQ1 and RQ2 were generated. On a conceptual level, accessibility and usability can be separated, yet in practice they intersect, and a strict separation was thus seen as neither functional nor feasible. Therefore, the results relating to accessibility and/or usability are presented in a combined manner in the following section.

3.0 Results

This study identified game-specific and non-game-specific barriers to and enablers of Lukukupla's accessibility and usability for LESLLA learners and teachers' proposed solutions in these categories (see Appendix 2, Figure 14). Firstly, specific technical features and mobile devices were classified as non-game-specific factors (see Appendix 2, Figures 15 and 16). Secondly, this study examined game-specific features such as navigation (see Appendix 2, Figure 17), auditory (see Appendix 2,

Figure 18) and visual elements (see Appendix 2, Figure 19). Additionally, teachers reported instructions (see Appendix 2, Figure 20), learning content (see Appendix 2, Figure 21), and feedback (see Appendix 2, Figure 22) as potentially impacting accessibility and usability for LESLLA learners and envisioned modifications and solutions accordingly. The results are discussed in detail in the following section.

3.1 Redesign of Non-game-specific Features

3.1.1 Technical Features and Mobile Devices: Considering Motor skills and Visibility Issues

Teachers unanimously valued the game app's functionality, which enabled a bug-free user experience and independent gaming. However, the login procedure required an email address. This compulsory operation with written input was perceived as problematic, because it impacted LESLLA users' independent practice. Talvi emphasized that LESLLA learners cannot be presumed to have an email address or access to one. Based on their previous experience, teachers stressed that particularly at the initial stages of using a digital serious game, LESLLA learners required human support because the login procedure necessitated literacy skills. To enhance accessibility and ease memorisation, a single-access password for both username and password, such as the learner's name or system/teacher-generated login details, was proposed.

Mobile devices were regarded to both enable as well as restrict accessibility and usability for LESLLA learners. Teachers stressed the importance of touch screens and their familiarity for learners with emerging motor skills, as LESLLA learners have been found to encounter challenges in operating external mouses or QWERTY keyboards. Teachers tested Lukukupla on their smartphones and found menu symbols and other visuals difficult to see on their small screens. Valo's user experience illustrated the effect screen size can have on navigation: "That screen is really small, especially when you have presbyopia [age-related farsightedness] and even when I'm wearing glasses it feels like no matter how hard you try to press, it won't respond" (Vit1). Both Valo and Havu had encountered LESLLA learners with vision problems, but without the means or a mentor to get glasses. In addition to the lack of (suitable) glasses, teachers suspected that their learners' visual problems working with mobile devices might stem from inadequate training. Thus, non-game-specific features involving motor skills and visibility issues need to be considered in a LESLLA-specific design.

3.2 Redesign of Game-specific Features

3.2.1 Navigation: Control and Clarity

Reduced visibility, induced by the small screen size of mobile devices, can affect user experience of efficient navigation on screen: "I couldn't always get the avatar to move, but probably my sausage fingers and

the small screen are the problem" (Vgd1). Uncontrolled navigation, enabling the player to move the avatar forwards and backwards (indicated by the dashed line in Figure 2 below), was perceived to further compromise usability. This option was seen to confuse inexperienced users and decrease meaningful on-task time.

Figure 2. *Game Navigation Example (Screenshot, Tgd1).*

To prevent idle screen time and support LESLLA learners' independent practice, teachers suggested direction control and recommended assisting users with simple oral instructions such as "turn right, turn left" (Vit2). Alongside auditory input, clear visual symbols and prompts were reported to potentially enhance navigation: the dashed line and arrow indicating direction were perceived as explicit (see Figure 2 above). However, for Talvi the exclamation mark's function remained elusive. Similarly, adults with emerging literacy in particular, can be confused by signs whose intended meaning they might not understand (Bruski, 2012; Strube et al., 2010).

3.2.2 Auditory Features: Avatar Voices and Background Music

The background music and some avatar voices were seen as potential barriers to an agreeable user experience. However, the perception of auditory features was highly individual. Valo, a "music person" (Vit2), highlighted the potentially positive impact of "evenly flowing" (Vit2) background music on sustaining motivation by shutting out external noise, particularly in a noisy environment. Prompted by the potentially disturbing effect of background music, Talvi questioned its purpose and benefit in a learning game that already contains ample auditory input requiring intensive listening. Recommended redesign actions included the addition of a simple on/off button and a button for users to control background music. Similarly, to cater for individual preferences, Havu suggested a range of different avatar voices.

3.2.3 Trauma Sensitivity

Two tasks involving shooting and underground digging, illustrated by screenshots in Figure 3 below, were identified to be highly trauma insensitive as their visual and/or auditory presentation might function as triggers for LESLLA learners. Isserlis (2010) reinforces that loud noise can cause strong startle reflexes and thus cause significant learner distraction.

Figure 3. *Shooting and Digging Exercise Example (Screenshots, Hit3).*

Drawing on their experience with traumatized LESLLA learners, Havu reflected on the potential impact of exercises involving shooting and digging on learners' wellbeing:

> You can often notice in class that we have a construction site on the adjacent lot and if there are [shooting] sounds, some people get really scared in such situations … and maybe similarly, in that digging task, being underground like that can be very distressing for someone if they had to hide like that underground and dig a passage for themselves. These [issues] are very difficult … to understand, but STILL if there is a game being made for people with low literacy … you must understand that their lives might be like that (Hit3).

Teachers considered trauma sensitivity fundamental for a LESLLA online learning and game design. The preventative deletion of content deemed to be potentially detrimental to learners' wellbeing was regarded as the only feasible option to avoid adverse learning effects.

3.2.4 Visual Features: Abundance, Avatars, and Aesthetics

Overall, teachers valued the game's visual aesthetics and highlighted their motivating effect on gaming practice. Teachers emphasised that

most of the visuals did not warrant acute modifications, even though all teachers perceived the illustrations as childish. Specific font and background colours were, nevertheless, reported to be visual barriers. For example, teachers said the white font against a dark background in target and distractor items "disturbed their eyes" (Vgd1) and affected legibility. They noted that a dark font on a light background better aided readability, see Figure 4 below. Replacing white fonts with black fonts is a simple modification that would increase the consistency of item appearance and thus also enhance usability.

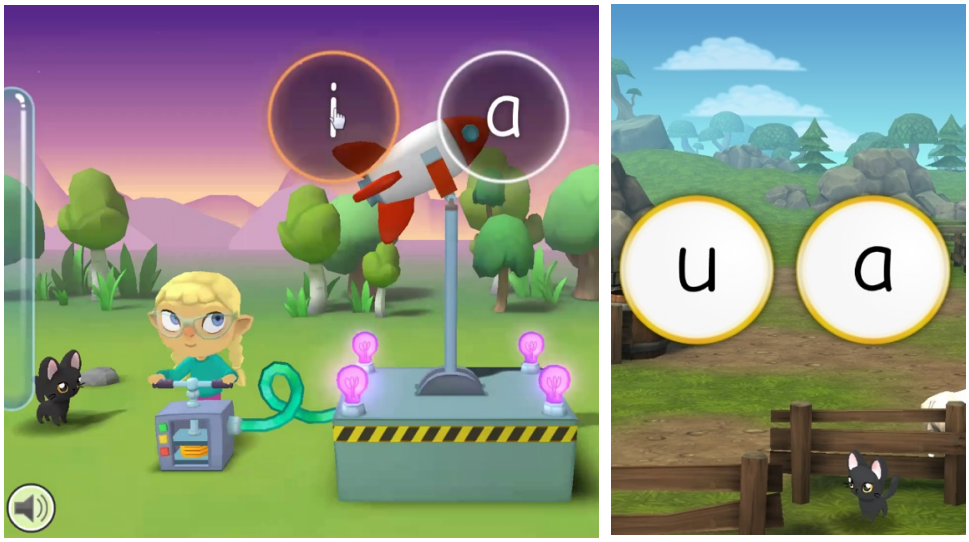

Figure 4. *Visibility Impairment Examination and Comparison (Screenshot, Vit2).*

The overabundance of visuals was reported as a major hurdle to accessibility and usability. To prevent visual distraction, teachers advocated including more visuals with game progression, thus enabling users to develop user skills and train their eyes so that "the eye learns to find" (Vit3). In addition to a progressive introduction of visuals, teachers also called for visuals supporting access to learning content. Talvi emphasized the importance of images depicting everyday objects and familiar environments such as home/room visuals to aid learners' meaningful decoding of unfamiliar L2 content.

Visual scaffolding, particularly in reading comprehension tasks, was found to be essential, and a mismatch between semantic and visual content was criticized, such as in the odd one out task *Apina kukka hyppii puussa* [The monkey flower jumps in the tree], see Figure 5 below. This task's visuals caused negative user reactions in Valo, who found the background picture "restless" (Vit3) and reported a decrease in concentration due to the cat's constant movements, indicated by an arrow in Figure 5.

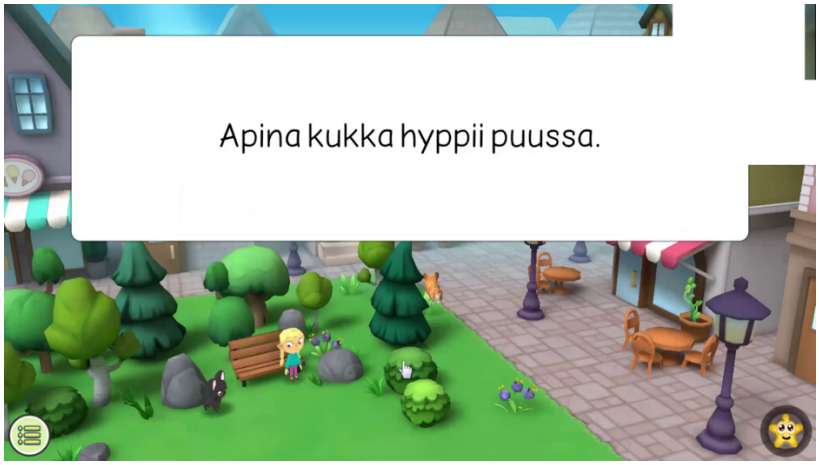

Figure 5. *Example of Overabundant and Irrelevant Visuals (Screenshot, Vit3).*

To enhance L2 learners' access to meaning and sustain their motivation, relevant (background) visuals could scaffold vocabulary and literacy learning, such as kitchen and food visuals relating to learning content: "When there's that image support, you can somehow try to guess if you don't know what a pea is or what a bean is" (Vit3). Avatar characters' visuals were perceived positively. Teachers valued individual customization options (different facial features, hair styles, skin colours, clothes) and recommended including more "identifiable" (Tit2) adult-looking avatars. Indeed, avatar customization can reinforce avatar identification (Takano & Taka, 2022) as reported by Havu: "Getting curly hair for my avatar made it look a bit like myself" (Hit1).

To enhance motivation, Havu encouraged further customization: "You could put headscarves and turbans in it" (Hit4). However, avatar identification for adult users with disparate backgrounds was also questioned and Valo proposed the introduction of non-human avatars: "Could it be an animal or even the sun or a star?" (Vit2). Previous studies discovered that identity representation is only one motivator in avatar creation (Lin & Wang, 2014) and found identification with avatars in learning environments to be lower compared to entertaining ones (Schrader, 2019). Regarding a LESLLA user population, reflecting on avatar function and whether further customization purposefully enhances usability or is a "secondary concern" (Tit2), as Talvi highlighted, is therefore advisable.

3.2.5 Instructions: Retrofitting for a Target Group of Emergent L2 Speakers

While all teachers repeatedly commented on the high-quality of the exercises, instructions were seen as key barriers to usability, limiting learners' access to learning content. The Finnish-only oral and written instructions were, due to their difficulty, complexity, and length, assessed to significantly compromise learner comprehension. Problem-

atic issues were highlighted in a task examination with Havu, illustrated by screenshots in Figure 6 below. In this phonological awareness task, learners were instructed, both orally and with a text displayed on screen, to listen carefully to which word, *lintu* [bird], *sormi* [finger], or *sorsa* [duck], began differently and to indicate their answer by clicking on the picture depicting the odd one out (*lintu*).

Figure 6. *Task Examination Focusing on Learner Instructions (Screenshots, Hit3).*

For LESLLA learners, instructions were identified as unintelligible, as they "are so impossibly difficult that it's really, really hard to know what to do when you don't understand anything" (Hit3). Havu advocated visualization to enhance the accessibility of instructions: "If li- and so- were marked with different colours, then it would be clear that what we're looking for here is how it [the word] starts" (Hit3). While Havu insisted on deleting all language-based instructions and replacing them with animations, Talvi recommended oral and written instructions in learners' home languages. Furthermore, a hybrid human-led approach familiarizing users in class with game tasks and instructions, ideally executed with multilingual support, such as teaching assistants, was proposed to boost individual comprehension. A manual introducing instructions and tasks in print or digital form was seen as a potential aid for teachers in this proposed classroom activity. Teachers also noted that comprehension could best be improved by the repetition of short, clear instructions with familiar lexicon. The use of synonyms was discouraged.

3.2.6 Game Story and Dialogues: Adequate Alternatives

Teachers were all extremely critical of the game story whose demanding target language use and lengthy oral and written prompts were expected to severely compromise comprehension (see game story example in Figure 7 below). Collectively, teachers criticized the story's unclear purpose and highlighted its perplexing effect on learners: "I think

the photons need to go. I believe they confuse [them]" (Tit2). The difficulty and relevance of the vocabulary, such as "photon, phone book, calibration, portal ball, chamber" (Vgd1), were also criticized.

Figure 7. *Game Story Example Exemplifying Conversation Length (Screenshot, Tgd1).*

Users listened to long oral game story conversations (see Figures 7 & 8a) and had to select written replies (as illustrated by Figure 8b below) to continue the dialogue. The lengthy written mode was reported to severely limit access to engaging and efficient usage for adult learners with emerging L2 literacy. The dialogues were also anticipated to increase meaningless clicking, thereby reducing efficient on-task learning time.

Figure 8a. *Game Story Example Demonstrating Context and Written Conversation Replies (Screenshot, Tgd2).*

Figure 8b. *Game Story Example Demonstrating Context and Written Conversation Replies (Screenshot, Tgd2).*

Teachers highlighted the unsuitability of the complex storytelling and irrelevant content for LESLLA learners, for example, collecting and creating stone structures (see Figure 8a) or collecting eggs for a birthday cake, and identified them as having a detrimental effect on user satisfaction:

> **I do think that this is not "fun or relaxing for the students, but perhaps confusing: What is this now?** Why is there such an item in this game, what should I do, what should I learn from this? (**Personally, I felt that building a stone structure was annoying** and at the end the question was asked: "Did you feel focused and calm?" Well, it didn't!😊😊" (Tgd2) (emphasis in original).

Accentuating the game story's inadequate contextual and linguistic content for LESLLA learners, teachers encouraged the integration of alternative L2 learning content, such as educational sessions explaining learning content, for example, "what is a verb"(Vit3), or appropriate vocabulary training by using its dialogue form (see Figures 8a & 8b above) in a relevant context: "What kind of ice cream you want to buy, you can then choose it from the kiosk, an option you can click on, whether it's strawberry ice cream, chocolate or vanilla" (Vit3).

3.2.7 Target and Distractor Items: Familiarity and Relevance

The teachers agreed that the role of lexical item familiarity and meaning was crucial. Unless target and distractor items were introduced by the game, learners could not be expected to know their meaning: "Otherwise it is unfair" (Hit3). Furthermore, Havu stressed word functionality, for example, *tree, cloud, house,* and *carrot* were presumed to be useful for LESLLA learners, whereas *angel, swan, buffalo, pirate, dragon* and *elephant,* were not considered relevant. Similarly, teachers accentuated the value of relevant, functional vocabulary. Nonword

items were suggested to be replaced with existing words. Phonological awareness tasks were recommended to be modified or replaced with specific reading and vocabulary tasks, as illustrated by Figure 9 below.

Figure 9. *Task Examinations Involving Nonword Exercises and Exercises with Written Word Forms and Target Item Depiction (Screenshots, Hit3).*

One solution proposed to enhance item recognition and memorization was their simultaneous presentation in written and auditory form: "Could that word also appear there, the written word for example under the picture, so that you would hear and see the word form?" (Vit2), see the screenshot on the right in Figure 9 above. Teachers also stressed that, for example in matching exercises, items should be presented in multiple ways to scaffold users in growing their lexicons.

The intentional ambiguity of target and distractor items was reported as one main accessibility barrier for adult L2 learners. Talvi presented an exercise containing the target item *pystykorva* (spitz) [literally "vertical ear"] and ear-related visuals, see Figure 10 below, emphasizing that

> I don't think that my students …would choose that picture of a dog because they hear KORVA [EAR], so they would automatically click on one of the other [pictures] … under no circumstances on the dog, because they don't understand that it's the name of a dog breed (Tit2).

Figure 10. *Example of Ambiguity of Target and Distractor Items (Screenshot, Tgd1).*

For Finnish-speaking children, the item choice and their visual ambiguity is deliberate and meant to enhance children's motivation. However, this ambiguity was seen as detrimental to LESLLA learners' comprehension and concentration. Therefore, teachers perceived the semantic choice of target and ambiguous distractor items as problematic for LESLLA learners.

3.2.8 Contextual/Cultural Knowledge: Adult L2 Learner Specific Topics

Besides a limited L2 lexicon, a redesign should also consider that L2 learners do not share the same cultural and contextual knowledge with L1 users, in this case Finnish-speaking children. Havu strongly advised against using lexical items linked to certain contextual or cultural objects, such as *Easter egg*, as they were not regarded as meaningful for LESLLA learners. For a redesign, teachers envisioned adult-specific topics and thematic units, with concurrent practice of vocabulary, numeracy, and literacy skills. "Familiar everyday words … colours, fruits, berries, furniture, clothes" (Vgd1) were seen to enhance L2 and literacy training the most, while also supporting and empowering learners in daily life as exemplified by Havu and Valo:

> The basic things like being able to go to the store, carrots, cauliflower, are important. You can buy things. And you can look up the price of something … when you don't know the name then it's empowering when you can learn these [words] (Hit3).

> Using money, recognizing coins, banknotes, the number symbol and the number. If you buy something from a kiosk, then you could click on the right amount of money ... so you understand the picture and when you hear that it's 20 euros, what you must choose (Vit3).

Ideally, this literacy support serious game could, according to the teachers, be redesigned as a multifunctional educational tool, not only enhancing L2 reading skills, but also other basic skills including digital and numeracy skills relevant to the LESLLA learners' realities.

3.2.9 Feedback: Encouraging LESLLA Learners

The in-task performance feedback's incoherent use of colour was identified as problematic. Correct answers were usually indicated by a green dot inside the target item and a green circle around it (see left screenshot in Figure 11). However, some target items were encircled by white circles (see Figure 11, screenshot on the right), rendering their feedback "unclear" (Vit2). Visibility was compromised, as colours were not always perceived as sufficiently intense to visualize immediate feedback (cf. Figure 4 above): "It [the red colour] was somehow so faded, I didn't immediately realize that it had gone wrong" (Vit2).

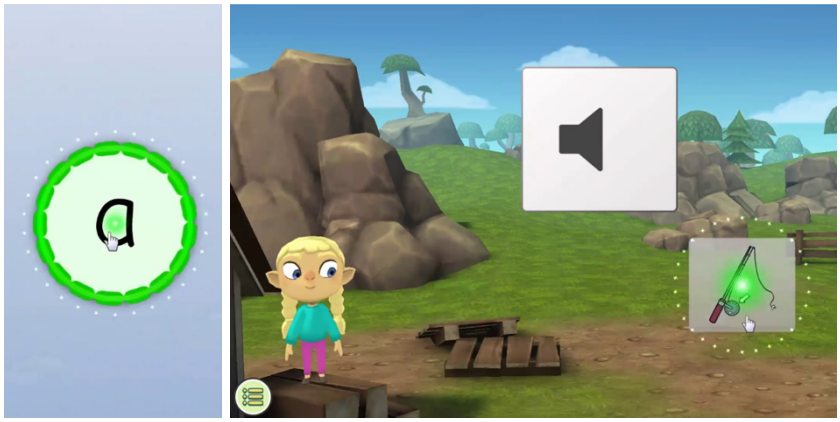

Figure 11. *Example of Incoherent Feedback Colour Use (Screenshots, Vit2).*

Against the backdrop of ample visuals and exercise tasks, consistent visual feedback was considered crucial: "That the continuation of the feedback would be the same even if the exercises changed, that feedback and evaluation would visually remain the same, so it would probably support and help" (Vit2). The post-task feedback included a plethora of visuals indicating learner performance: the avatar's facial expressions, stars, a happy and unhappy smiley face, the number of positive and negative answers and a percentage bar (see Figure 12 below).

Figure 12. *Post-task Feedback Example (Screenshot, Tgd1).*

While teachers unanimously evaluated this abundance of different indicators as overwhelming, the evaluation of specific visual performance indicators resulted in mixed results. Whereas Talvi evaluated the percentage display and the avatar's facial expressions positively, as "illustrative" (Tgd1), Valo and Havu underlined that the percentage bar was not a "functional" performance measure as LESLLA learners "don't necessarily even understand what it means, the percentage … they don't necessarily even understand that number. That number can be so large that they don't understand it" (Vit2).

Some of the avatar's facial impressions (see Figure 13) were seen to impact usability by evoking strong negative emotions: "It bothers me that my character's face is very angry if I do something wrong … It's scary. I get the feeling that by making a mistake, I make other people angry" (Hgd1). Instead of accentuating feedback potentially evoking negative emotions, teachers suggested concentrating on supportive learner feedback, e.g., by using instantaneous single-word oral praise "jes, hyvä, hienoa [yes, good, great]" (Tit2) to generate enjoyable user experiences.

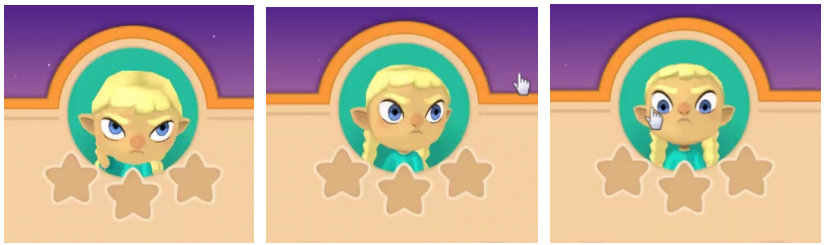

Figure 13. *Examples of the Avatar's Facial Impressions (Screenshots, Hit4).*

Oral-only L1-targeted post-task explanations were seen to be incomprehensible for LESLLA learners. To aid comprehension, displaying correct answers post-task and visualizing task objectives was recommended:

> It would be good if the explanation/feedback would have shown the spelling of the words and then indicated, for example by circling the beginnings of the words … what the idea of the task is (finding a word that starts differently) (Tgd2).

Teachers, however, unanimously questioned the relevance of rewards for adult users, as reported by Havu in their gaming diary:

> Has the game designer heard that in countries where immigrants with low literacy come from, they don't like pets at all? For the earned 'money' you must get equivalents that are also suitable for adults (clothes, facial expressions, hairstyles, accessories or even being able to decorate a house/cultivate a plot rather than moving ladybug stickers) (Hgd1).

Teachers proposed to either delete irrelevant rewards (such as stickers or pets accompanying the avatar) or to include meaningful reward, advocating for a purposeful introduction of motivation-boosting rewards in a LESLLA-targeted game design of the future *LESLLA Lukukupla* game app.

4.0 Discussion

This study identified potential barriers LESLLA learners face in the accessibility and usability of *Lukukupla*, a literacy support serious game app designed for Finnish-speaking children not adult emergent L2 readers. Furthermore, it elicited prospective enablers and solutions for enhancing LESLLA learners' user experience of the game. This study showed that, to be LESLLA learner-compatible, a children-focused serious game warrants a redesign while also highlighting the value of participatory design with relevant stakeholders in educational settings.

Overall, the complex written and oral target language use, directed at L1 users, especially in instructions, feedback, and the game story, was seen as the main barrier to learning content accessibility and game app usability. Teachers emphasized the relevance and familiarity of topics and target items presented as learning content. Furthermore, teachers stressed the importance of in-game vocabulary practice for L2 literacy learners. Because vocabulary knowledge is known to have a strong effect on reading comprehension (Grabe & Stolle, 2013), a (re)designed LESLLA-focused literacy support environment could, ideally, function as a lexicon expander. In addition to engaging narratives and linguistically accessible stories, Young-Scholten et al. (2015) emphasize the role of images that "provide cues to the text or expand on the information provided in the text, but [do] not tell the story" (p. 56), thus

supporting the teachers' call for visual scaffolding for the LESLLA learners. A LESLLA-focused design should consider combining visual literacy practice and *pleasure reading* to support users in their transition from word recognition to text comprehension (see Wilkinson & Young-Scholten, 2011; Young-Scholten & Limon, 2015).

Visual features, recurrently examined and envisioned, were identified as dominant game features. While their overabundance was criticized, visual scaffolding was seen to enhance learner comprehension and independence. Clear and consistent visualization with visuals relating to learning content, visual scaffolding of learning instructions, and feedback were perceived as particularly user-friendly. DeCapua (2019) emphasizes that due to LESLLA learners' limited exposure to formal education they must learn "what it means to 'do school'" (p. 14) and recommends "contextualization and clear connections to students' lived experiences" (p. 31) to make instructions accessible for learners with limited formal education experience, who are usually synchronously learning new content as well as how to participate in formal schooling (DeCapua & Marshall, 2022). Similarly, Friedman et al. (2022) emphasize the importance of explicit instruction; aiming for "both illustrative and familiar" examples is therefore imperative, because "an example that is not resonant for learners will do nothing to illustrate an unfamiliar concept" (p. 293). LESLLA learners' feedback "needs to be at a level learners can process and needs to be focused on the grammatical and linguistic forms that are being targeted in the classroom at that time" (Burt et al., 2008, p. 3).

Usability was seen to be affected by irrelevant or even detrimental game features, such as trauma insensitive visual and auditory elements or the avatar's facial expressions, which might cause negative emotional reactions. Previous studies on the effect of background music on learning have not reported conclusive results (de la Mora Velasco & Hirumi, 2020), thus the use of background music in a LESLLA design should be considered critically. In a LESLLA design, it is crucial to consider how exposure to sensory input in a digital learning environment can have an adverse effect on LESLLA learners with refugee backgrounds and traumatic experiences. As LESLLA learners tend to be troubled by past trauma (see Isserlis, 2010; Järvinen & Suopajärvi, 2024) and serious social and emotional needs (see Linville & Pentón Herrera, 2022), considering their impact on learning (see Bigelow & Watson, 2012; Tomren & Opaas, 2024) and learners' emotional responses is essential.

In line with previous research on LESLLA learners' realities and reactions and the need to acknowledge these, I argue that potential trauma-triggers must be carefully inspected, and trauma-informed practices devised when designing learning environments, particularly serious games, for learners with a potential refugee background. Consequently, design solutions that avoid the undesirable effects of affective factors on language learning while fostering positive emotions and learning experiences (see MacIntyre, 2021; Oxford, 2016) should be

favoured. Previous research on the affective quality of game character design features in learning games confirmed that avatar facial expressions can have a significant effect on affective arousal and learner motivation (Chen et al., 2012; Plass et al., 2020).

As LESLLA learners struggle with working memory and cognitive demands in formal education (see Kurvers & van de Craats, 2007), a LESLLA-proof design should further consider memory and cognitive skill scaffolding. To prevent working memory overload, Friedman et al. (2022) encourage "fully-guided and targeted instructions … explaining new concepts explicitly in digestible, carefully-sequenced chunks, with well-thought definitions and familiar examples, as well as appropriately-scaffolded, guided practice" (p. 290). A redesign should further carefully consider the nature and necessity of target and distractor items, prioritizing items enhancing LESLLA learners' lexicon and literacy development, as researchers have found that LESLLA learners struggle with working memory issues (Kurvers & van de Craats, 2007) and people with low literacy have significant difficulties to memorize nonwords (Huettig, 2015).

Technical functionality was considered a vital enabler of usability and elements enhancing visibility and legibility such as a dark font on a light background and a progressive introduction of visuals were found to be imperative for an adult-centred design. Potential visual impairments and age-related visibility issues must be carefully considered in a design targeted at an adult migrant user population, as "persons with disabilities make up around 15% of the global population, and comprise a significant minority of refugees and migrants" (FRA, n.d.). The under-identification of special needs among LESLLA learners is a critical issue in migrant education (see Pentón Herrera, 2021). Many refugees and migrants who become LESLLA learners are unaware of their individual special needs, including visual impairments, and remain undiagnosed. As the smartphone is the most used mobile device for LESLLA learners, a LESLLA design needs to cater for vision impairment needs and visibility issues.

This study's results demonstrate that considering LESLLA-specific learner characteristics and needs as well as usability and accessibility requirements must be a priority in the design of adequate digital learning and gaming environments for LESLLA learners. LESLLA learners perceive the meaning of visual prompts and images often contrarily from the intended meaning as their meaning-making is experiential, based on their personal experiences and history (Altherr Flores, 2017, 2021a). Altherr Flores (2021a) highlights the importance of the "social semiotics of literacy – the interplay of context, culture, history, text, and meaning-making" (p. 2) for LESLLA learning material. Therefore, a LESLLA-proof redesign of a visually rich learning environment must devote particular attention to semiotics and, furthermore, visual literacy expectations must be critically examined and meaning-making processes thoroughly considered so that multimodal elements can be modified and adapted accordingly (see Altherr Flores, 2021a, 2021b).

Finally, a LESLLA-centred design must acknowledge that many learners have not only emerging literacy skills but also limited numerical skills and struggle with interpreting abstract visual representations such as charts (DeCapua, 2019; Williams & Chapman, 2008).

Against the backdrop of continuing and emerging crises, which accelerate global migration, innovative educational technology solutions meeting LESLLA learners' educational needs and empowering them in their private and professional capacities are in demand. Redesigning and retrofitting existing digital learning tools and environments in a DBR approach, ideally in collaboration with relevant stakeholders, might present a feasible opportunity to develop digital innovations for a specific learner population in conditions and contexts with restricted time, human, and financial resources. If designers are provided with proper technical functionality and support, they could then predominantly focus on redeveloping meaningful learning content for specific learner populations, such as LESLLA learners. Possible solutions and modifications to enhance the accessibility and usability of a specific literacy support mobile learning game described in this article can be applied and transferred to the (re)design of other digital learning environments targeted at adult migrants with limited formal education background.

5.0 Conclusion

This study's findings highlight the importance of accessible, user-friendly educational technology and serious games. Moreover, the results confirm the importance of Ahola and Hartikainen's (2022) pedagogical, technological, and lingual accessibility criteria for LESLLA learners. Arguing that effective and enjoyable learning environments including serious games must be redesigned according to their intended end user group's needs, I join Altherr Flores'(2021b) appeal to designers to "critically reflect on their own design assumptions in order to provide … users with more appropriate opportunities for making meaning and demonstrating their knowledge and skills" (p. 12). While this study evaluated a specific serious game, the redesign suggestions (see Appendix 2) can be used as guidelines in the design process of other serious games and digital learning environments targeted at LESLLA learners and may help designers prioritize LESLLA-focused decision-making.

This study highlighted the value of redesigning existing educational technology and DBR in educational settings. By illuminating the potential of participatory design with stakeholders in adult migrant education, this study intends to initiate an intradisciplinary discussion of learning technology in LESLLA education. Even though LESLLA teachers are not the intended end users of digital literacy support games, their role in advocating for digital learning material and supporting LESLLA

learners in enhancing their independent digital learning skills is undeniable. Engaging teachers and learners in the design process has the potential to not only enhance a digital literacy support prototype with a more unbiased, participant-centred game design, but furthermore to create an essential balance between entertaining and educational elements based on the various stakeholders' varied expertise and experience. Establishing such a balance between gaming and didactic elements in a participatory design process could enhance and benefit future designs of serious games and online learning environments significantly (see Westera, 2022).

While this participatory design project tremendously benefited from the teachers' expertise, experience, and enthusiasm, the game evaluation by external non-target-group members was also a limitation. Due to this study's explorative nature, further studies are needed to support proposed design choices of the small sample of self-selected participants. In future investigations, it might be possible to collaborate directly with targeted end-users, that is, LESLLA learners, in a participatory design project involving learner-relevant educational technology (see Bradley et al., 2020; Chinen & Almeida, 2023; Pacheco-Velazquez et al., 2023) and complementary empathy-based design and teaching approaches (see Hyökki et al., 2024; Jiancaro, 2018; Mercer, 2016; Oxford, 2016). Further research is needed to establish the potential of educational technology for LESLLA and generate empirical evidence for technology-equipped learning in LESLLA education. Future studies on the role of LESLLA learners' emotions and social and emotional learning (SEL) of LESLLA learners in MALL/TELL practices and educational technology design (see Plass et al., 2020) are also recommended.

The creation of a LESLLA Lukukupla prototype and its field-testing with learners were beyond the scope of this study. It is expected that once the game is redesigned for LESLLA learners, a future retrofitted prototype would correspond more explicitly to the needs of adult emerging readers. The redesign guidelines for LESLLA learners' mobile learning environments presented in this article (see Appendix 2) can be employed by the Lukukupla game design team to create a LESLLA Lukukupla prototype to be field-tested and validated with learners. In the future, a learning game primarily designed for children would thus also be suitable for the teaching of adult migrants, supporting and enhancing the mechanical and meaningful practice of adult L2 literacy skills in the Finnish language. This would therefore enhance both the learning experience as well as the experimental conditions for future usability and efficacy studies on L2 literacy serious games. To investigate learner efficacy and enjoyment, evidence-based validation will be essential.

6.0 References

Aberdeen, T. (2019). Teaching LESLLA learners how to use Chromebooks: Challenges and possibilities. *LESLLA Symposium Proceedings*, *11*(1), 47–55. https://doi.org/10.5281/zenodo.8035733

Adams, B., Rotsaert, T., Schellens, T., & Valcke, M. (2020). Pre-service teachers as designers in the context of advertising literacy education. *EDeR. Educational Design Research*, *3*(1). https://doi.org/10.15460/eder.3.1.1412

Ahola, M., & Hartikainen, A. (2022). Lesson learned of tablet course for semi-literate immigrants. *Human Interaction & Emerging Technologies (IHIET-AI 2022): Artificial Intelligence & Future Applications. AHFE (2022) International Conference. AHFE Open Access, Vol. 23. AHFE International, USA.* https://doi.org/10.54941/ahfe100844

Altherr Flores, J. A. (2017). Social semiotics and multimodal assessment of L2 adult emergent readers from refugee backgrounds. *LESLLA Symposium Proceedings*, *12*(1), 9–31. https://doi.org/10.5281/zenodo.8035875

Altherr Flores, J. A. (2021a). The interplay of text and image on the meaning-making processes of adult L2 learners with emerging literacy: Implications for test design and evaluation frameworks. *Language Assessment Quarterly*, *18*(5), 508–529. https://doi.org/10.1080/15434303.2021.1984491

Altherr Flores, J. A. (2021b). The semiotics of writing: How adult L2 learners with emergent literacy make meaning in assessment texts through writing. *Journal of Second Language Writing*, *51*, 100793. https://doi.org/10.1016/j.jslw.2021.100793

Bayne, S. (2015). What's the matter with 'technology-enhanced learning'? *Learning, Media and Technology*, *40*(1), 5–20. https://doi.org/10.1080/17439884.2014.915851

Belzer, A., Leon, T., Patterson, M., Rhodes, C., Salas-Isnardi, F., Vanek, J., Webb, C., & Willson-Toso, B. (2020). COVID-19 rapid response report from the field. *ProLiteracy*. https://www.proliteracy.org/wp-content/uploads/2023/07/2020-07_EBAES-COVID19_white-paper.pdf

Bigelow, M., & Tarone, E. (2004). The role of literacy level in second language acquisition: Doesn't who we study determine what we know? *TESOL Quarterly*, *38*(4), 689–700. https://doi.org/10.2307/3588285

Bigelow, M., & Vinogradov, P. (2011). Teaching adult second language learners who are emergent readers. *Annual Review of Applied Linguistics*, *31*, 120–136. https://doi.org/10.1017/S0267190511000109

Bigelow, M., & Watson, J. (2012). The role of educational level, literacy, and orality in L2 learning. In S. M. Gass & A. Mackey (Eds.), *The Routledge handbook of second language acquisition* (pp. 461–475). Routledge.

Bogaerds-Hazenberg, S., Evers-Vermeul, J., & van den Bergh, H. (2019). Teachers and researchers as co-designers? A design-based re-

search on reading comprehension instruction in primary education. *EDeR. Educational Design Research*, *3*(1). https://doi.org/10.15460/eder.3.1.1399

Borleffs, E., Zwarts, F., Siregar, A. R., & Maassen, B. A. M. (2020). GraphoLearn SI: Digital learning support for reading difficulties in a transparent orthography. *Human Technology*, *16*(1), 92–111. https://doi.org/10.17011/ht/urn.202002242164

Bradley, L., & Al-Sabbagh, K. W. (2022). Mobile language learning designs and contexts for newly arrived migrants. *Australian Journal of Applied Linguistics*, *5*(3), 1–20. https://doi.org/10.29140/ajal.v5n3.53si5

Bradley, L., Bartram, L., Al-Sabbagh, K. W., & Algers, A. (2020). Designing mobile language learning with Arabic speaking migrants. *Interactive Learning Environments*, 1–13. https://doi.org/10.1080/10494820.2020.1799022

Bradley, L., Berbyuk Lindström, N., & Sofkova Hashemi, S. (2017). Integration and language learning of newly arrived migrants using mobile technology. *Journal of Interactive Media in Education*, *3*(1), 1–9. https://doi.org/10.5334/jime.434

Bratteteig, T., Bødker, K., Dittrich, Y., Mogensen, P. H., & Simonsen, J. (2013). Methods: Organising principles and general guidelines for participatory design projects. In J. Simonsen & T. Robertson (Eds.), *Routledge international handbook of participatory design* (pp. 117–144). Routledge. https://doi.org/10.4324/9780203108543

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bruski, D. (2012). Graphic device interpretation by low-literate adult ELLs: Do they get the picture? *Minnesota and Wisconsin Teachers of English to Speakers of Other Languages.* https://hdl.handle.net/11299/162757

Burt, M., Kreeft Peyton, J., & Schaetzel, K. (2008). Working with adult English language learners with limited literacy: Research, practice, and professional development. *CAELA Network Brief October 2008*. https://www.cal.org/caelanetwork/pdfs/LimitedLiteracyFinalWeb.pdf

Cezarotto, M., Martinez, P., & Chamberlin, B. (2022). Redesigning for accessibility: Design decisions and compromises in educational game design. *International Journal of Serious Games*, *9*(1), 17–33. https://doi.org/10.17083/ijsg.v9i1.469

Chen, G.-D., Lee, J.-H., Wang, C.-Y., Chao, P.-Y., Li, L.-Y., & Lee, T.-Y. (2012). An empathic avatar in a computer-aided learning program to encourage and persuade learners. *Educational Technology & Society*, *15*(2), 62–72.

Chinen, L. G., & Almeida, L. D. A. (2023). Participatory design with migrants in language learning contexts in Brazil: A systematic literature review. In M. Rauterberg (Ed.), *Culture and Computing* (pp. 509–523). Springer Nature Switzerland.

Cucchiarini, C., Dawidowicz, M., Filimban, E., Tammelin-Laine, T., van de Craats, I., & Strik, H. (2015). The digital literacy instructor:

Developing automatic speech recognition and selecting learning material for opaque and transparent orthographies. *LESLLA Symposium Proceedings*, *10*(1), 251–278. https://lesllasp.journals.publicknowledgeproject.org/index.php/lesllasp/article/view/5539

Cucchiarini, C., Deutekom, J., & Strik, H. (2013). The digital instructor for literacy learning. *Proceedings of the SLaTE-2013 Workshop*, 96–101. https://www.isca-archive.org/slate_2013/cucchiarini13_slate.pdf

Cumbo, B., & Selwyn, N. (2022). Using participatory design approaches in educational research. *International Journal of Research & Method in Education*, *45*(1), 60–72. https://doi.org/10.1080/1743727X.2021.1902981

D'Agostino, M., & Mocciaro, E. (2021). Literacy and literacy practices: Plurilingual connected migrants and emerging literacy. *Journal of Second Language Writing*, *51*, 100792. https://doi.org/10.1016/j.jslw.2021.100792

Dannecker, W., Carell, L., Spieß, S., Ambrosini, C., & Ziemen, K. (2024). Literary learning with digital media in inclusive settings: Insights and results from the DBR-project 'DigiLi' focussing [sic] on students' cooperation. *EDeR. Educational Design Research*, *8*(2). https://doi.org/10.15460/eder.8.2.2170

de la Mora Velasco, E., & Hirumi, A. (2020). The effects of background music on learning: A systematic review of literature to guide future research and practice. *Educational Technology Research and Development*, *68*(6), 2817–2837. https://doi.org/10.1007/s11423-020-09783-4

DeCapua, A. (2019). *SLIFE. What every ESL teacher needs to know.* (First paperback edition 2023). University of Michigan Press.

DeCapua, A., & Marshall, H. W. (2022). Making space for students with limited or interrupted formal education in teacher education. In L. J. Pentón Herrera (Ed.), *English and students with limited or interrupted formal education: Global perspectives on teacher preparation and classroom practices* (pp. 125–139). Springer. https://doi.org/10.1007/978-3-030-86963-2_8

Delius, K. (2022). Fachdidaktische Innovationen im Unterricht anstoßen: Eine Design-Based Research-Studie zur Förderung der Sprechkompetenz im Englischunterricht. *EDeR. Educational Design Research*, *6*(3). https://doi.org/10.15460/eder.6.3.1704

DiSalvo, B., Yip, J., Bonsignore, E., & DiSalvo, C. (2017). Participatory design for learning. In B. DiSalvo, J. Yip, E. Bonsignore, & C. DiSalvo (Eds.), *Participatory design for learning. Perspectives from practice and research.* (pp. 1–6). Routledge.

Drepper, L. (2024). Multiperspectivity in the context of design-based research: Theoretical-methodological considerations to reading literacy at the end of primary school. *EDeR. Educational Design Research*, *8*(2). https://doi.org/10.15460/eder.8.2.2204

Drolia, M., Papadakis, S., Sifaki, E., & Kalogiannakis, M. (2022). Mobile learning applications for refugees: A systematic literature review. *Education Sciences*, *12*(2), 96. https://doi.org/10.3390/educsci12020096

Eilola, L., & Lilja, N. (2021). The smartphone as a personal cognitive artifact supporting participation in interaction. *The Modern Language Journal*, *105*(1), 294–316. https://doi.org/10.1111/modl.12697

Filimban, E. (2019). *The effectiveness of a computer software program for developing phonemic awareness and decoding skills for low-literate adult learners of English* [Doctoral dissertation, Newcastle University]. http://theses.ncl.ac.uk/jspui/handle/10443/4873

FRA (European Union Agency for Fundamental Rights). (n.d.). *Thematic focus: Migrants with disabilities* [Online post]. https://fra.europa.eu/en/content/thematic-focus-migrants-disabilities

Friedman, Z. B., Laitflang, R. J., & Pilosoph, A. D. (2022). The case for explicit instruction for adult SLIFE. In L. J. Pentón Herrera (Ed.), *English and students with limited or interrupted formal education: Global perspectives on teacher preparation and classroom practices* (pp. 285–300). Springer. https://doi.org/10.1007/978-3-030-86963-2_16

Gillespie, J. (2020). CALL research: Where are we now? *ReCALL*, *32*(2), 127–144. https://doi.org/10.1017/S0958344020000051

Grabe, W., & Stolle, F. L. (2013). *Teaching and researching: Reading, Vol. eBook* (2nd ed.). Routledge.

Guichon, N. (2024). Reviewing research methods on adult migrants' digital literacy: What insights for additional language teaching? *Apples – Journal of Applied Language Studies*, *18*(1), 67–89. https://doi.org/10.47862/apples.137177

Hautala, J., Heikkilä, R., Nieminen, L., Rantanen, V., Latvala, J.-M., & Richardson, U. (2020). Identification of reading difficulties by a digital game-based assessment technology. *Journal of Educational Computing Research*, *58*(5), 1003–1028. https://doi.org/10.1177/0735633120905309

Hersh, M. A., & Leporini, B. (2014). An overview of accessibility and usability of educational games. In Information Resources Management Association (Ed.), *Assistive technologies: Concepts, methodologies, tools, and applications* (pp. 63–101). IGI Global. https://doi.org/10.4018/978-1-4666-4422-9.ch005

Hertzum, M. (2022). *Usability testing: A practitioner's guide to evaluating the user experience* (Vols. 1–45). Springer.

Holz, H., Brandelik, K., Beuttler, B., Brandelik, J., & Ninaus, M. (2018). How to train your syllable stress awareness – A digital game-based intervention for German dyslexic children. *International Journal of Serious Games*, *5*(3), 37–59. https://doi.org/10.17083/ijsg.v5i3.242

Huettig, F. (2015). Literacy influences cognitive abilities far beyond the mastery of written language. In I. van de Craats, J. Kurvers, &

R. van Hout (Eds.), *Adult literacy, second language and cognition* (pp. 115–128). Centre for Language Studies (CLS).

Hyökki, S., Pääkkönen, K., Nam, K., & Miettinen, S. (2024). Bridging the gap between human and technology: Using empathic design strategically to provide citizen-friendly services. *Human Technology*, *20*(2), 224–243. https://doi.org/10.14254/1795-6889.2024.20-2.2

International Standard Organization. (2010). *Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems. 9, 10, 11, 13, 47*.

Isserlis, J. (2010). Trauma and learning – What do we know, what can we learn? *LESLLA Symposium Proceedings*, *5*(1), 42–51. https://doi.org/10.5281/zenodo.8004065

Järvinen, M., & Suopajärvi, T. (2024). Differences in the classroom: Gender, race, and trauma as affective hotspots in Finnish education for adult migrants. *NORA – Nordic Journal of Feminist and Gender Research*, *33*(1), 86–100. https://doi.org/10.1080/08038740.2024.2367753

Jiancaro, T. (2018). Empathy-based design approaches. In M. Filimowicz & V. Tzankova (Eds.), *New Directions in Third Wave Human-Computer Interaction: Volume 2 – Methodologies* (pp. 43–60). Springer. https://doi.org/10.1007/978-3-319-73374-6_4

Kaufmann, K. (2018). Navigating a new life: Syrian refugees and their smartphones in Vienna. *Information, Communication & Society*, *21*(6), 882–898. https://doi.org/10.1080/1369118X.2018.1437205

Kreeft Peyton, J., & Young-Scholten, M. (Eds.). (2020). *Teaching adult immigrants with limited formal education: Theory, research and practice*. Multilingual Matters.

Kuo, R., & Chang, M. (2019). Guest editorial: Guidelines and taxonomy for educational game and gamification design. *Educational Technology & Society*, *22*(3), 1–3.

Kurvers, J., Stockmann, W., & van de Craats, I. (2010). Predictors of success in adult L2 literacy acquisition. *LESLLA Symposium Proceedings*, *5*(1), 64–79. https://doi.org/10.5281/zenodo.8004075

Kurvers, J., & van de Craats, I. (2007). Memory, second language reading, and lexicon: A comparison between successful and less successful adults and children. *LESLLA Symposium Proceedings*, *2*(1), 65–80. https://doi.org/10.5281/zenodo.7992924

Lin, H., & Wang, H. (2014). Avatar creation in virtual worlds: Behaviors and motivations. *Computers in Human Behavior*, *34*, 213–218. https://doi.org/10.1016/j.chb.2013.10.005

Linville, H. A., & Pentón Herrera, L. J. (2022). Why, how, and where to advocate for English learners with limited or interrupted formal education. In L. J. Pentón Herrera (Ed.), *English and students with limited or interrupted formal education: Global perspectives on teacher preparation and classroom practices* (pp. 61–82). Springer. https://doi.org/10.1007/978-3-030-86963-2_5

Lotas, S. V. (2021). The COVID-19 pandemic from an adult literacy practitioner-scholar perspective: Where we were, where we are, and where we should be going. *Adult Literacy Education*, *3*(2), 50–54. https://doi.org/10.35847/SLotas.3.2.50

MacIntyre, P. D. (2021). Exploring applications of positive psychology in SLA. In K. Budzińska & O. Majchrzak (Eds.), *Positive psychology in second and foreign language education* (pp. 3–17). Springer. https://doi.org/10.1007/978-3-030-64444-4_1

Malessa, E. (2018). Learning to read for the first time as adult immigrants in Finland: Reviewing pertinent research of low-literate or non-literate learners' literacy acquisition and computer-assisted literacy training. *Journal of Applied Language Studies, 12*(1), 25–54. https://doi.org/10.17011/apples/urn.201804051932

Malessa, E. (2021). From computer-assisted to technology-enhanced learning. Lessons learnt and fast forward toward (digital) literacy of LESLLA learners. *LESLLA Symposium Proceedings*, *14*(1), 327–345. https://lesllasp.journals.publicknowledgeproject.org/index.php/lesllasp/article/view/6262

Malessa, E. (2023a). Enhancing ethical research participation and inclusion of marginalized adult migrant learners: An early career researcher's perspective. *Forum Qualitative Sozialforschung*, *24*(3), Article 17. https://doi.org/10.17169/fqs-24.3.4100

Malessa, E. (2023b). How Covid-19 intruded and improved my applied LESLLA research in progress: Reflections on research-design and research ethics of an empirical serious game study on L2 literacy support of adult migrants in Finland. *LESLLA Symposium Proceedings, 17*(1), 111–126. https://doi.org/10.5281/zenodo.8075621

Malessa, E. (2023c). Technology-enhanced or technology-exhausted learning in adult migrant literacy education in Finland: Exploring teachers' experiences and views in pre-pandemic and pandemic times. *International Journal of Technology in Education and Science (IJTES), 7*(2), 104–128. https://doi.org/10.46328/ijtes.4371

Malessa, E., & Filimban, E. (2017). Exploring what log files can reveal about LESLLA learners' behaviour in an online call environment. *LESLLA Symposium Proceedings, 12*(1), 149–158. https://doi.org/10.5281/zenodo.8058969

Mercer, S. (2016). Seeing the world through your eyes: Empathy in language learning and teaching. In P. D. MacIntyre, T. Gregersen, & S. Mercer (Eds.), *Positive Psychology in SLA* (pp. 91–111). Multilingual Matters. https://doi.org/doi:10.21832/9781783095360-004

Minuz, F., & Kurvers, J. (2021). LASLLIAM. A European reference guide for LESLLA learners. *LESLLA Symposium Proceedings*, *14*(1), 453–470. https://lesllasp.journals.publicknowledgeproject.org/index.php/lesllasp/article/view/6269

Naeb, R., & Sosiński, M. (2020). Technology-enhanced learning (TEL) in the LESLLA context. In M. Planelles Almeida, A. Foucart, & J. Liceras (Eds.), *Perspectivas actuales en la enseñanza y el aprendizaje de lenguas en contextos multiculturales (Colección*

Ciencias Sociales y Humanidades) (pp. 299–339). Thomson Reuters.

Ngan, H. Y., Lifanova, A., Jarke, J., & Broer, J. (2016). Refugees welcome: Supporting informal language learning and integration with a gamified mobile application. In K. Verbert, M. Sharples, & T. Klobučar (Eds.), *Adaptive and Adaptable Learning* (pp. 521–524).Springer. https://doi.org/10.1007/978-3-319-45153-4_54

Norlund Shaswar, A. (2021). Digital literacy practices in everyday life and in the adult L2 classroom: The case of basic literacy education in Swedish. In G. S. Levine & D. Mallows (Eds.), *Language learning of adult migrants in Europe. EDUL, 53.* Springer. https://doi.org/10.1007/978-3-030-79237-4_8

Ojanen, E., Ronimus, M., Ahonen, T., Chansa-Kabali, T., February, P., Jere-Folotiya, J., Kauppinen, K.-P., Ketonen, R., Ngorosho, D., Pitkänen, M., Puhakka, S., Sampa, F., Walubita, G., Yalukanda, C., Pugh, K., Richardson, U., Serpell, R., & Lyytinen, H. (2015). GraphoGame – a catalyst for multi-level promotion of literacy in diverse contexts. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00671

Oxford, R. L. (2016). Toward a psychology of well-being for language learners: The 'EMPATHICS' vision. In P. D. MacIntyre, T. Gregersen, & S. Mercer (Eds.), *Positive Psychology in SLA* (pp. 10–88). Multilingual Matters. https://doi.org/doi:10.21832/9781783095360-003

Pacheco-Velazquez, E., Rodes-Paragarino, V., Rabago-Mayer, L., & Bester, A. (2023). How to create serious games? Proposal for a participatory methodology. *International Journal of Serious Games*, *10*(4), 55–73. https://doi.org/10.17083/ijsg.v10i4.642

Pentón Herrera, L. J. (2021). Caring as a form of advocacy for literacy-emergent newcomers with special education needs: The community-building pedagogical approach in the U.S. In P. Vinogradova & J. K. Shin (Eds.), *Contemporary foundations for teaching English as an additional language: Pedagogical approaches and classroom applications* (pp. 265–269). Routledge.

Pentón Herrera, L. J. (Ed.). (2022). *English and students with limited or interrupted formal education: Global perspectives on teacher preparation and classroom practices.* Springer. https://doi.org/10.1007/978-3-030-86963-2

Plass, J. L., Homer, B. D., MacNamara, A., Ober, T., Rose, M. C., Pawar, S., Hovey, C. M., & Olsen, A. (2020). Emotional design for digital games for learning: The effect of expression, color, shape, and dimensionality on the affective quality of game characters. *Understanding and Measuring Emotions in Technology-Rich Learning Environments*, *70*, 101194. https://doi.org/10.1016/j.learninstruc.2019.01.005

Puolakanaho, A., & Latvala, J. (2017). Embedding preschool assessment methods into digital learning games to predict early reading skills. *Human Technology*, *13*(2), 216–236. https://doi.org/10.17011/ht/urn.201711104212

Reina-Reina, C., Antón, E., & Duñabeitia, J. A. (2024). Impact of a cognitive training on reading of 6-year-old children. *International Journal of Serious Games*, *11*(3), 45–69. https://doi.org/10.17083/ijsg.v11i3.754

Reinders, H. (2017). Digital games and second language learning. In S. L. Thorne & S. May (Eds.), *Language, Education and Technology* (pp. 329–343). Springer. https://doi.org/10.1007/978-3-319-02237-6_26

Richardson, U., & Lyytinen, H. (2014). The GraphoGame method: The theoretical and methodological background of the technology-enhanced learning environment for learning to read. *Human Technology*, *10*(1), 39–60. https://doi.org/10.17011/ht/urn.201405281859

Rillera Kempster, J. (2023). Digital poetry for adult English learners with limited education: Possibilities in language learning, literacy development and interculturality. *TESOL in Context*, *31*(2), 5–22. https://doi.org/10.21153/tesol2023vol31no2art1727

Robertson, T., & Simonsen, J. (2013). Participatory design. An introduction. In J. Simonsen & T. Robertson (Eds.), *Routledge International Handbook of Participatory Design* (pp. 1–17). Routledge. https://doi.org/10.4324/9780203108543

Ronimus, M., & Lyytinen, H. (2015). Is School a Better Environment than Home for Digital Game-Based Learning? The Case of GraphoGame. *Human Technology*, *11*(2), 123–147. https://doi.org/10.17011/ht/urn.201511113637

Rosen, D. J., & Vanek, J. (2017). Technology for innovation and change in adult basic skills education. *New Directions for Adult and Continuing Education*, *155*, 51–60. https://doi.org/10.1002/ace.20240

Schrader, C. (2019). Creating avatars for technology usage: Context matters. *Computers in Human Behavior*, *93*, 219–225. https://doi.org/10.1016/j.chb.2018.12.002

Slaughter, Y., & Choi, J. (2024). The affordances of identity texts with adult students with limited or interrupted formal education. *English Teaching & Learning*. https://doi.org/10.1007/s42321-024-00184-x

Smyser, H. (2019). Adaptation of conventional technologies with refugee language learners: An overview of possibilities. In E. Sengupta & P. Blessinger (Eds.), *Language, teaching, and pedagogy for refugee education* (pp. 125–139). Emerald. https://doi.org/10.1108/S2055-364120180000015010

Spinuzzi, C. (2005). The methodology of participatory design. *Technical Communication*, *52*(2), 163–174.

Strube, S. (2014). *Grappling with the oral skills: The learning and teaching of the low-literate adult second language learner*. LOT.

Strube, S., van de Craats, I., & Van Hout, R. (2010). Telling picture stories: Relevance and coherence in texts of the non-literate L2 learner. *LESLLA Symposium Proceedings*, *5*(1), 52–63. https://doi.org/10.5281/zenodo.8004069

Sykes, J. M., & Reinhardt, J. (2013). *Language at play: Digital games in second and foreign language teaching and learning*. Pearson Education.

Takano, M., & Taka, F. (2022). Fancy avatar identification and behaviors in the virtual world: Preceding avatar customization and succeeding communication. *Computers in Human Behavior Reports*, *6*, 100176. https://doi.org/10.1016/j.chbr.2022.100176

Tammelin-Laine, T., Vaarala, H., Savolainen, J., & Bogdanoff, M. (2020). Technology-supported L2 learning in LESLLA classes: Two case studies from Finland. *LESLLA Symposium Proceedings*, *15*, 86–107. https://lesllasp.journals.publicknowledgeproject.org/index.php/lesllasp/article/view/6165

Tarone, E., Bigelow, M., & Hansen, K. (2009). *Literacy and second language oracy*. Oxford University Press.

Tarone, E., Hansen, K., & Bigelow, M. (2013). Alphabetic literacy and adult SLA. In J. Herschensohn & M. Young-Scholten (Eds.), *The Cambridge Handbook of Second Language Acquisition* (pp. 180–204). Cambridge University Press; Cambridge Core. https://doi.org/10.1017/CBO9781139051729.012

Tomren, J. F., & Opaas, M. (2024). Adult refugees' perspectives on the impact of trauma and post-migration hardships on learning. *European Journal of Psychotraumatology*, *15*(1), 2403249. https://doi.org/10.1080/20008066.2024.2403249

Tour, E., Creely, E., Waterhouse, P., Pham, X., Henderson, M., & Wallace, M. (2023). Navigating challenging digital literacy practices: The settlement experiences of adults from migrant and refugee backgrounds. *Adult Education Quarterly*, *73*(4), 422–441. https://doi.org/10.1177/07417136231180867

Tuhkala, A. (2021). A systematic literature review of participatory design studies involving teachers. *European Journal of Education*, *56*(4), 641–659. https://doi.org/10.1111/ejed.12471

UNESCO (Institute for Lifelong Learning). (2022). *Leveraging innovative technology in literacy and education programmes for refugees, migrants and internally displaced persons*. https://unesdoc.unesco.org/ark:/48223/pf0000382626

van de Craats, I., & Young-Scholten, M. (2015). Developing technology-enhanced literacy learning for LESLLA learners. *LESLLA Symposium Proceedings*, *9*(1), 129–150. https://doi.org/10.5281/zenodo.8022528

Westera, W. (2019). Why and how serious games can become far more effective: Accommodating productive learning experiences, learner motivation and the monitoring of learning gains. *Educational Technology & Society*, *22*(1), 59–69.

Westera, W. (2022). The devil's advocate: Identifying persistent problems in serious game design. *International Journal of Serious Games*, *9*(3), 115–124. https://doi.org/10.17083/ijsg.v9i3.547

Wilkinson, M., & Young-Scholten, M. (2011). Writing to a brief: Creating fiction for immigrant adults. *LESLLA Symposium Proceedings*, *6*(1), 104-123. https://doi.org/10.5281/zenodo.8004306

Williams, A., & Chapman, L. (2008). Meeting diverse needs: Content-based language teaching and settlement needs for low literacy adult ESL immigrants. *LESLLA Symposium Proceedings*, *3*(1), 125–136. https://doi.org/10.5281/zenodo.8000830

Woods, D. M., Gifford, D. B., Yovanoff, P., & Sandoval, A. (2023). The effects of an adult literacy app on word decoding. *Adult Literacy Education*, *5*(3), 22–39. https://doi.org/10.35847/DWoods.DGifford.PYovanoff.ASandoval.5.3.22

Young-Scholten, M. (2021). Second language linguistic competence and literacy of adult migrants with little or no home language literacy. In H. Mohebbi & C. Coombe (Eds.), *Research questions in language education and applied linguistics*. Springer Texts in Education. https://doi.org/10.1007/978-3-030-79143-8_46

Young-Scholten, M., & Limon, H. (2015). Creating new fiction for low-educated immigrant adults: Leapfrogging to digital. *The International Journal of the Book 2015*, *13*(4), 1–9.

Young-Scholten, M., Sosiński, M., & Rubio, A. M. (2015). Undergraduates' involvement in producing short fiction books for immigrant adult beginners in England and Spain. *Language Issues: The ESOL Journal*, *26*(1), 55–60.

Young-Scholten, M., & Strom, N. (2006). First-time L2 readers: Is there a critical period? *LESLLA Symposium Proceedings*, *1*(1), 45–68. https://doi.org/10.5281/zenodo.7980398

Zelezny-Green, R., Vosloo, S., & Conole, G. (2018). *Digital inclusion for low-skilled and low-literate people: A landscape review.* UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000261791

Appendix 1.

Template of a guiding question list for teachers' gaming diaries (translated by the author)

• Use the keyword and question list on the next page. If you wish, you can for example focus on different areas each week. Observations should be recorded during each game, so that they are not forgotten.

Date, gaming time (circa)	Device (smartphone, tablet)	Observation, feedback, question	Own experience	LESLLA user experience as assessed by the teacher
30.10.2020 20 min	Samsung Galaxy J3	2.1 …	…	
1.11.2020 15 min	Samsung Galaxy Tab A 4G	…	…	…
2.11.2020 15 min	Samsung Galaxy J3	… screenshot 2.11.2020		…

1. Pre-testing	
1.1 Accessing the game (Acquiring the test version), was it easy to download the game?	
1.2 Game log-in (Creating a new user, starting the game, ending it), how did it go when creating a new user, logging into the game and creating an avatar? What do you think of these steps from a literacy student's perspective?	

1.3 Teachers' remote testing instructions (researcher's written instructions, functionality of screenshots), were the instructions clear, were the screenshots useful?	
2. Device-specific considerations	continuously
2.1 (Mobile) Device-specific considerations (if possible, test the game on different mobile devices)	
2.2 Functionality of the game, visibility on the (small) screen of mobile devices	
2.3 Further feedback, other observations, comments, e.g., flaws in the game	continuously
3. Game features	e.g., during the 1st week of testing
3.1 Visual appearance: game character; use of colours, use of images in assignments	
3.2 Background story (content, duration of different sections, linguistic scope)	
3.3 Navigation of the game character, i.e., how the game character moves in the game world. Is movement easy, difficult on the touch screen?	
3.4 Technical quality of the game (size of words/pictures, volume of sound stimuli used in learning tasks, i.e., sounds, words and sentences)	
4. Game instructions and feedback	e.g., during the 2nd week of testing
4.1 Content, comprehensibility, length of instructions in general. Are they comprehensible, of a	

suitable length, do they convey the essential point?	
4.2 Verbal instructions (vocabulary of instructions, speaking speed)	
4.3 Written instructions	
4.4 Feedback: 1. During the task, immediate feedback to the player (right or wrong, correct answer). 2. Post-task (visual, verbal comment) feedback to the player.	
5. Game tasks	e.g., during the 3rd week of testing
5.1 Visual, functional context (applicability, functionality) of different tasks: basic game, climbing game, rocket game, ghost game, hurdle race, train game, temple game, pirate game...	
5.2 Didactic content of different tasks (applicability, functionality): choose the sound/word you hear; odd one out. How does the content of the tasks (chosen words, used sentences, gradual difficulty of the tasks) suit LESLLA teaching, individual students?	
5.3 Instructions for different task types (oral)	
5.4 Task types and their applicability, functionality, functionality	
5.5 The body of the learning content, possible shortcomings, from which point of view should there be more exercises, is there something important for	

learning to read and write that should still be added?	
6. Language-specific matters and conversations contained in the game	e.g., during the 4th week of testing
6.1 Use of the Finnish language, speaker's voice. How does the language work in instructions, feedback, tasks?	
6.2 Potential effects of LESLLA learners' home languages, potential problems of different language groups	
6.3 Conversations in the game: Game story and questions addressed to the player and the answer options offered. How do you think they work from a player's point of view, from a LESLLA learner's point of view?	

Appendix 2.

Visualization of barriers to and enablers of Lukukupla's accessibility and usability and teachers' proposed solutions in these categories

Colour-coding and shape legend:

- not-game specific features: grey, rectangular;
- game-specific features: purple, rectangular;
- perceived barriers and their proposed negative impact on usability/accessibility: orange, rectangular;
- perceived enablers and their proposed positive effect on usability/accessibility: green, rectangular;
- suggested solutions: green, oval.

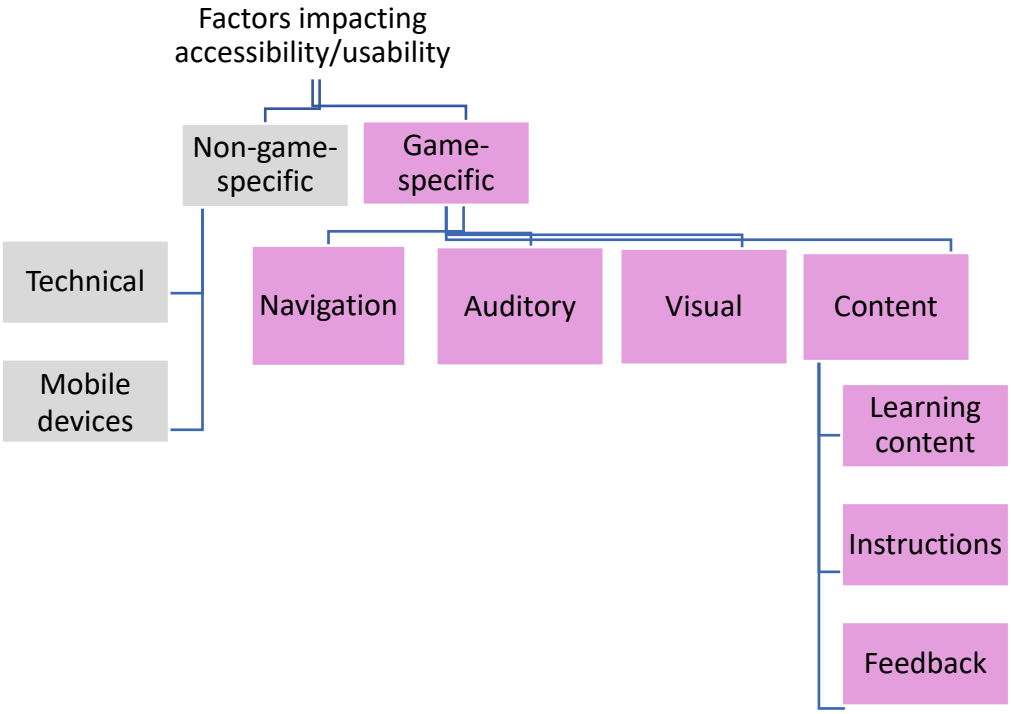

Figure 14. *Non-game-specific and game-specific factors impacting accessibility and usability*

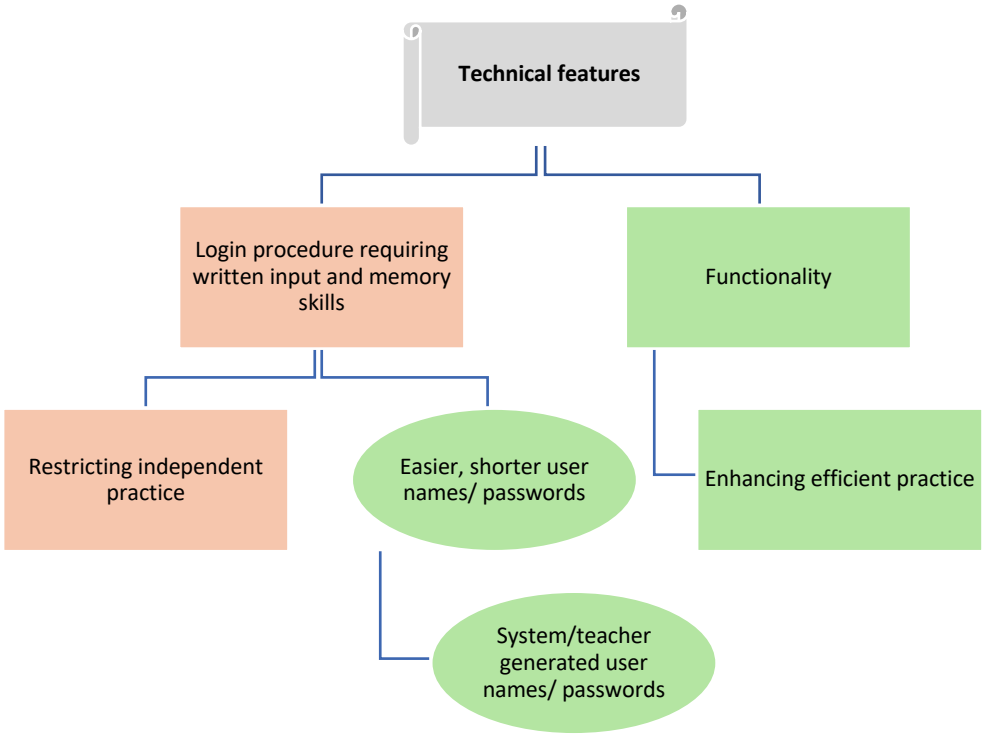

Figure 15. *Technical features: Perceived barriers to/enablers of/solutions for accessibility and usability*

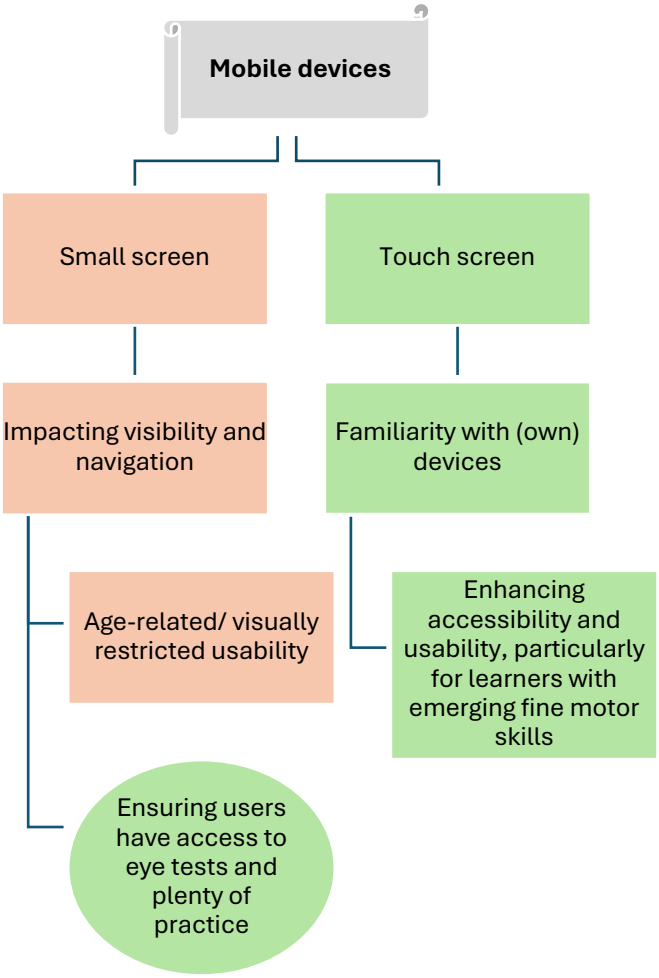

Figure 16*. Mobile devices: Perceived barriers to/enablers of/solutions for accessibility and usability*

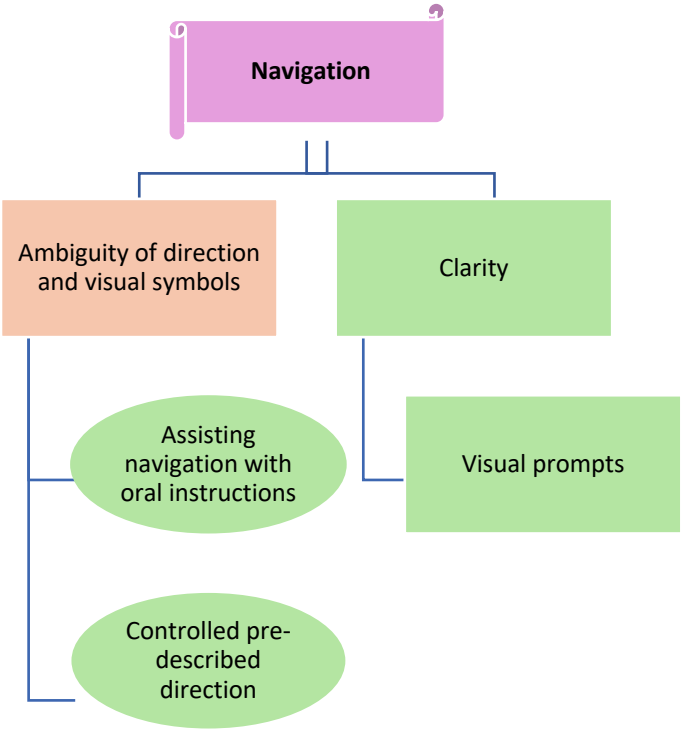

Figure 18. *Auditory features: Perceived barriers to/enablers of/solutions for accessibility and usability*

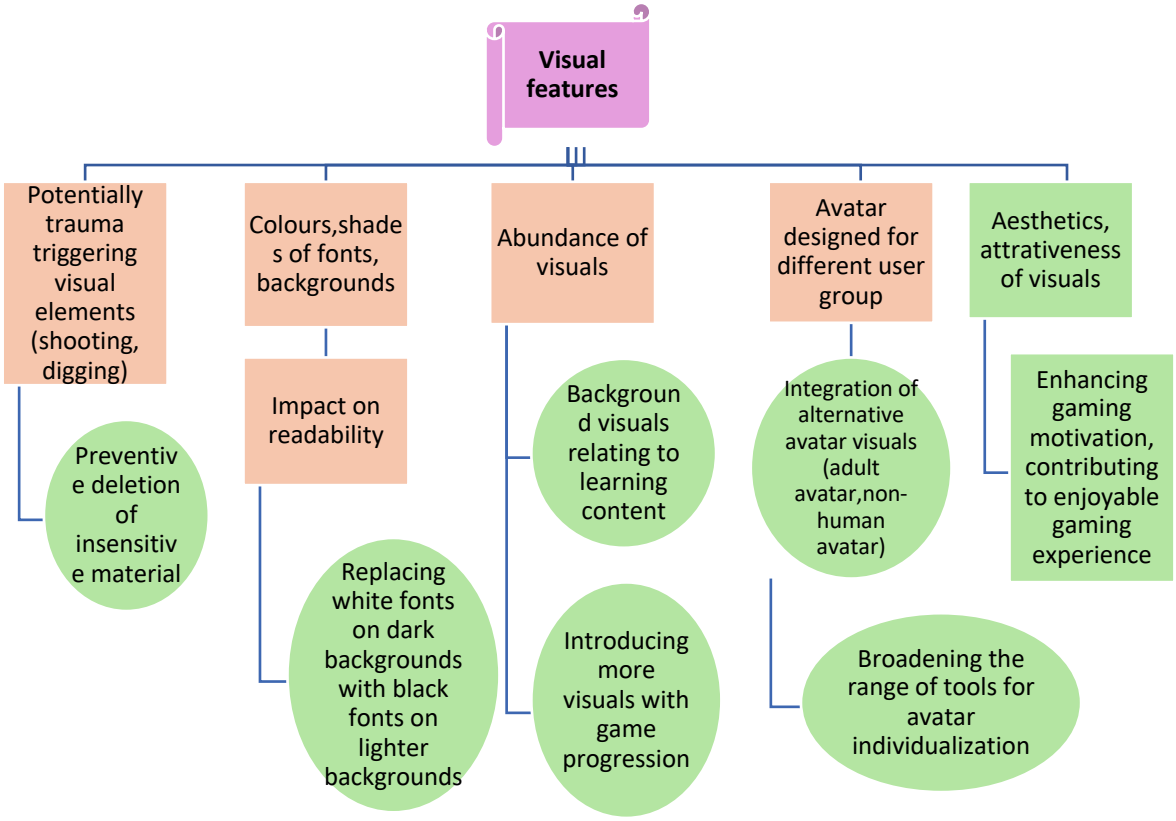

Figure 19. *Visual features: Perceived barriers to/enablers of/solutions for accessibility and usability*

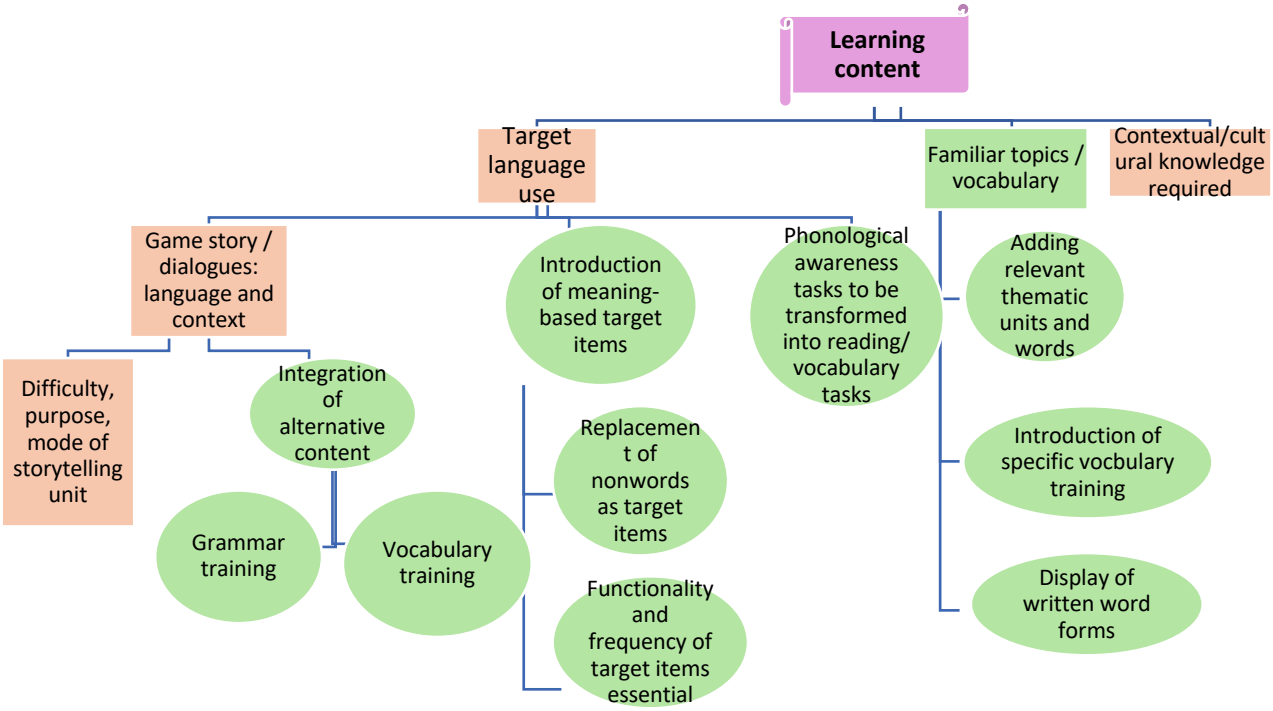

***Figure 20**. Instructions: Perceived barriers to/enablers of/solutions for accessibility and usability*

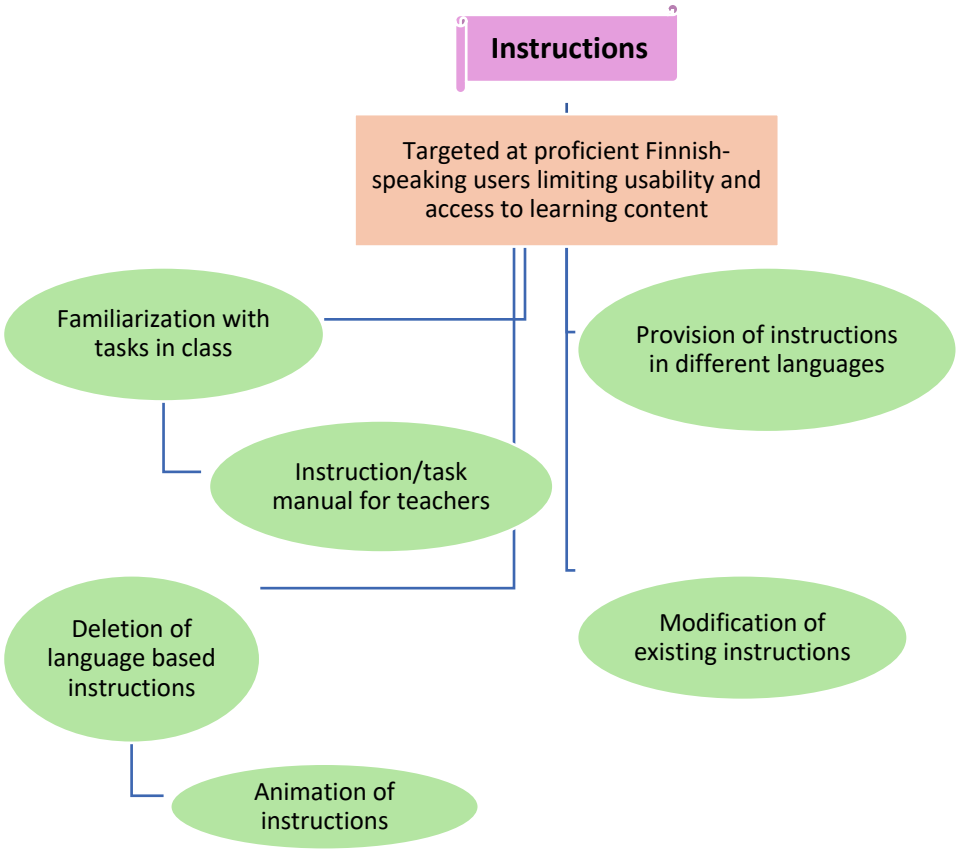

Figure 21. *Learning content: Perceived barriers to/enablers of/solutions for accessibility and usability*

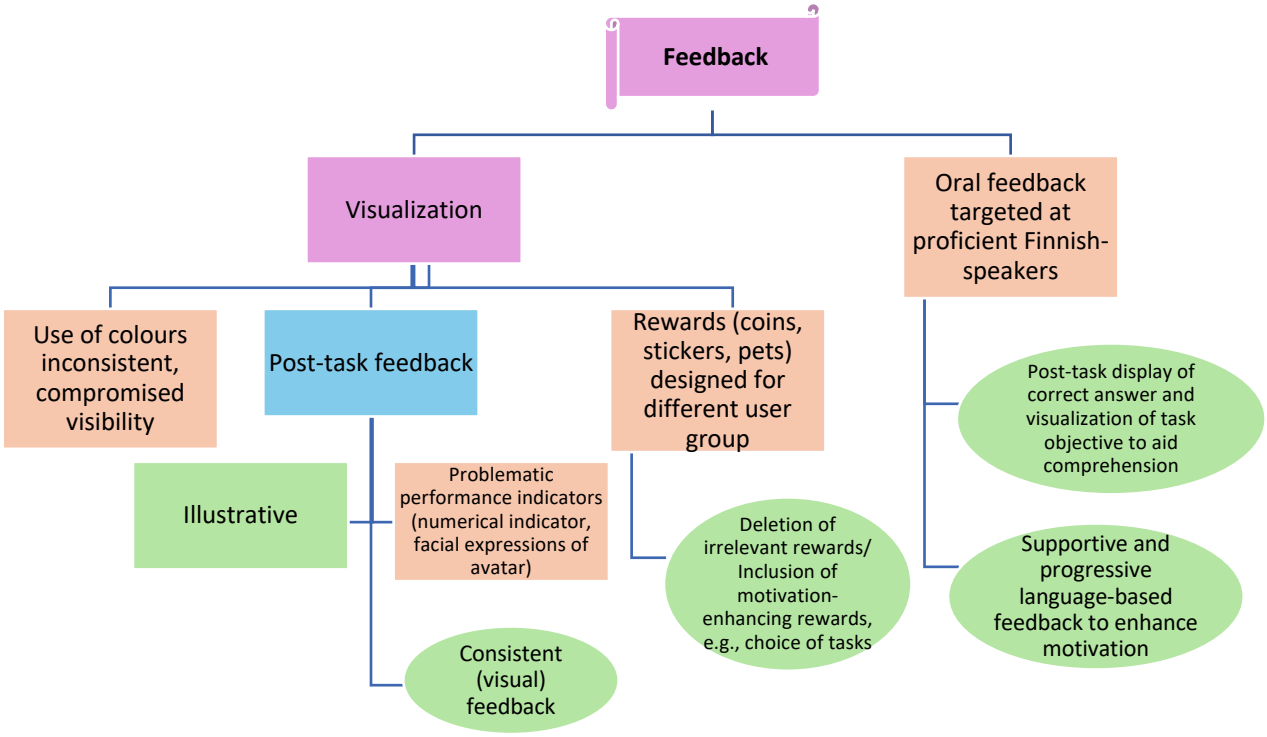

Figure 22. *Feedback: Perceived barriers to/enablers of/solutions for accessibility and usability*

Author Profile

Eva Malessa (PhD, Applied Language Sciences) is currently working as a project researcher at the University of Turku, Finland, exploring education for sustainable development (ESD) in language education. For the last decade she has been involved in LESLLA research, specializing in technology-mediated literacy training and teaching of adult emergent second language readers. Further, she has a strong interdisciplinary research interest in ethical (research) practices, sustainability, and practitioner-focused research.

Author Details

Eva Malessa
University of Turku
FI-20014 Turun yliopisto
Finland
+358 29 450 5000
eva.malessa@utu.fi

Editor Details

Prof. Dr. Tobias Jenert
Chair of Higher education and Educational Development
University of Paderborn
Warburger Straße 100
Germany
+49 5251 60-2372
Tobias.Jenert@upb.de

Journal Details

EDeR – Educational Design Research
An International Journal for Design-Based Research in Education
ISSN: 2511-0667
uhh.de/EDeR
#EDeRJournal (our hashtag on social media services)

Published by

Hamburg Center for University Teaching and Learning (HUL)
University of Hamburg
Schlüterstraße 51
20146 Hamburg
Germany
+49 40 42838-9640
+49 40 42838-9650 (fax)
EDeR.HUL@uni-hamburg.de
hul.uni-hamburg.de

In collaboration with

Hamburg University Press
Verlag der Staats- und Universitätsbibliothek Hamburg – Landesbetrieb
Von-Melle-Park 3
20146 Hamburg
Germany
+49 40 42838 7146
info.hup@sub.uni-hamburg.de
hup.sub.uni-hamburg.de