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Readers Theater in Desktop VR: A Pilot Study with Grade Nine Students

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Abstract: Appropriate techniques for promoting reading fluency are difficult to implement in the classroom. There is little time to provide students with individualized feedback on reading aloud or to motivate them to do so. In this context, Virtual Reality (VR) can be beneficial for learning because it allows for individualized feedback and for increasing learner engagement. Studies that analyze established methods of language learning in VR at school are thus far lacking. Therefore, this pilot study is one of the first to analyze student acceptance of reading fluency training in desktop VR at a secondary school. The interview guide was developed in accordance with the Technology Acceptance Model. The desktop VR environment is web-based and provides individual and collaborative opportunities for training reading fluency, giving, and receiving feedback, and deepening content understanding of reading texts. To analyze the acceptance of the desktop VR environment, five guided interviews were conducted. The results reveal that despite various technical challenges within the VR environment, students not only accepted but also appreciated the reading fluency training in VR. The integration of established concepts of reading fluency training in foreign language classrooms has great potential as an additional value in addressing the challenges of face-to-face instruction.

Keywords: virtual reality; reading fluency training; language learning; acceptance; students; secondary school

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1. Introduction

In the past, reading aloud was commonly employed in first language (L1) and second language (L2) learning to train reading fluency with reference to the skill of reading accurately, in a meaningful way, and with appropriate expression. Reading fluency training has gained popularity in L1 education after studies have made it evident that reading competence in L1 is closely linked to reading fluency [1]. While such research findings are limited, evidence suggests that reading fluency is also important for L2 learners [2,3].

Repeated reading of a text, assisted reading, and model reading have been proven to positively affect reading fluency [1]. However, these techniques require substantial amounts of time and resources. In addition, appropriate reading fluency instruction can hardly be met in school settings, as teachers already face a number of challenges such as the growing heterogeneity among their student bodies [4]. Subsequently, there is little to no time for each student to read aloud and receive sufficient feedback from the teacher. Additionally, motivating students to read aloud frequently proves difficult due to the perceived monotony of reading aloud activities [5]. Therefore, reading fluency training needs to be developed further by individualizing the learning process and student support, as well as making it more appealing. Moreover, training should reach beyond scholarly settings, giving students the chance to practice at home and allowing for “seamless learning” [6] (p. 98).

The overall objective of this project is, therefore, to evaluate student acceptance of a technology-based learning activity based on Virtual Reality (VR) and corresponding learning environments. The principle learning design draws from the Multilingual Readers' Theater (MELT), in which groups of students practice reading fluency using multilingual, dialogical texts until they are able to read them aloud fluently and expressively, and then perform them in plenum. The readers' theater (RT) is one of the reading-aloud methods that is able to achieve significant improvement in the area of reading fluency with regard to correct word recognition, reading speed, and prosody, while also significantly increasing young learners' motivation to read [7,8]. MELT and RT are based on cooperative role-playing, narrative approaches that provide an excellent starting point for research in the development of cooperative, VR-based methods for fostering foreign language learning.

The development of a digital system that is based on the previous approaches, MELT and RT, promises increased efficiency, easier structuring of the learning process, online collaboration, seamless learning at home and at school, and a more satisfying user experience for digital natives. Adding VR to MELT aims to provide students with a realistic and motivating learning experience that allows for flexible collaboration options. Using this backdrop, the specific objective of the project is to address the question: To what extent do students accept the use of MELT in the foreign language classroom in a VR environment? Furthermore, what are the specific internal (e.g., student motivation) and external factors (e.g., the design and features of the VR learning environment) that may influence student acceptance of VR applications in the foreign language classroom? Subsequently, what are the potential problems of VR application in MELT that need to be worked out? The research questions that guide this research are thus:

1. What internal and external factors influence a given student's intentions to use and accept VR in the context of MELT?
2. To what extent do students accept the performance of the reading fluency training phase of MELT in a VR application?
3. To what extent does VR have the potential to be used in foreign language classrooms to complement MELT?

This paper is organized as follows. First, related work is presented, with a specific focus on reading fluency and related technology-based approaches, such as the Technology Acceptance Model, and the application of VR in school-related learning scenarios in language learning. Second, the VR conception and design are described, followed by the study methodology. Third, the results are discussed; the research questions are addressed; and the conclusions are drawn. Lastly, the implications for the future design of VR applications in foreign language teaching are presented.

2. Related Work

2.1. Reading Fluency

Reading fluency (RF), a central factor in literacy, requires the mastery of accuracy, automaticity, and prosody [9]. Strategies that have a high potential for training RF are repeated reading and assisted reading [10]. Repeated reading of a text is used to strengthen automaticity in word recognition so that a reader's cognitive resources can be used for comprehension rather than the decoding of individual words [11]. Assisted reading refers to the "oral reading of a text while simultaneously listening to a fluent rendering of the same text" [12] (p. 514) which can be performed by a partner, a group choral reading, or an audio recording. Practicing assisted reading speeds up the learning progress, especially for text comprehension [12]. In combination with repeated reading, assisted repeated reading benefits reading speed, word recognition, as well as overall comprehension [13].

Even though RF is a central skill for educational, occupational, and societal success, it is rarely explicitly tackled in classroom settings, which is likely the result of method limitations. Most reading interventions require extensive amounts of time and human resources, both of which are scarce due to the growing heterogeneity of learner needs in the classroom, among other difficulties [4,14]. Further, weak readers are not able to improve their reading by practicing solely in school [15]. In addition, assisted and repeated reading require the monotonous task of reading the same text multiple times, which commonly lowers student motivation and prevents them from staying engaged for longer periods of time. These challenges cause the use of such interventions to fall short of their full potential [5].

2.2. Readers Theater

RT embeds repeated and assisted reading in a meaningful and motivational context because this method focuses on practicing a script that will eventually be performed in front of an audience [16]. "Readers Theatre, as well as other kinds of performance, gives students an authentic reason to engage in repeated reading of texts", Worthy and Prater [17] (p. 295) note. Moreso, this method focuses on meaning and comprehension instead of reading rate [16,17]. Rather than stereotypical theater, the use of props, costumes, and stage settings are rare in readers theater. Consequently, actors convey meaning by using appropriate intonation, rate, and accentuation [16,18]. Instead of text memorization, performers read from scripts. This shifts the purpose from memorization towards decoding words and adding them to the reader's visual vocabulary [19]. Additionally, readers can focus on precise and expressive oral reading, thus practicing prosody.

While traditional RT is constructed monolingually, its multilingual version allows practicing RF in several languages at the same time. MELT recognizes multilingualism in heterogeneous classrooms, allowing the inclusion of school language, foreign languages, and students' native tongues [19]. Furthermore, this method is able to provide a cooperative learning setting in which student heterogeneity is seen as a resource. In this setting, students with stronger reading skills support those with weaker skills by acting as reading models who also provide feedback [19]. Kutzelmann et al. [20] have created an eight-phase plan to guide teachers through the implementation of MELT in their classrooms (see Figure 1).

Teaching–Learning Process	***Social form***	***Approx. time***
1. Teacher introduces Multilingual Readers' Theatre	PL	15-20
2. Teacher reads book passages aloud	PL	5-10
3. Pupils read script scenes and are assigned roles	IW/GW	10-15
4. Pupils summarize content of their scenes	GW	15-25
5. Pupils introduce scenes and individual roles	PL	15-25
6. Pupils practice roles and provide mutual feedback	PW	20-45
7. General rehearsal and feedback	GW	20-45
8. Final performance	PL	25-45

Figure 1. Eight–phase MELT structure [20].

In addition to training RF in multiple languages, MELT has the potential to positively impact other areas of foreign language learning, such as listening comprehension, pronunciation, and vocabulary training [19]. The method further aims to promote social learning and reduce fear associated with speaking foreign languages simply because MELT's means of practice depends on group interaction. One study documents a high acceptance of this design on the part of the teachers and learners [19]. Teachers have also acknowledged its potential in terms of promoting RF, second language learning, and beyond. However, a comprehensive quantitative evaluation is still pending [19].

2.3. Digital Technologies and Reading Fluency Training

Digital approaches specifically targeted at the enhancement of RF used to be scarce. The Peabody Literacy Lab [21], a technology-based intervention for older school children, consists of a reading lab, a word lab, and a spelling lab. Instructions and feedback are provided by an animated tutor. Compared to a control group, the system was found to significantly foster auditory vocabulary, literal comprehension, inferential comprehension, and total reading comprehension.

Automatic speech recognition (ASR) was employed by Adams [22] and Mostow et al. [23]. In both cases, a Reading Assistant [22] or Reading Tutor [23] listens to a student reading aloud and provides feedback. Mostow's ASR provides feedback and gives supporting functions. Reading skills of students whose first language is English and also of students learning English as a second language [24] were improved in proof-of-concept studies. Adam's system additionally creates performance reports to assist teachers in monitoring student growth. In a 17-week study of grade 2–5 classrooms, she found that students using the Reading Assistant showed significantly greater gains in RF than students in the control group.

One study combined podcasting technology with traditional RT [25]. During a ten-week intervention, students practiced a new theater script each week that was then recorded and published online as podcasts. Results showed that publishing podcasts online not only increased the authenticity of the RT for the students, but also allowed them to self-evaluate, revise, and improve their reading performance.

Furthermore, RF training has also been enhanced with digital tools related to gamification [26,27]. For instance, GameLet implements meaningful digital media-based gamification mechanisms for the purpose of increasing pupil motivation in self-directed, individual, and cooperative learning in RF training [28].

Until recently, the few technology-based approaches used to complement classroom activities linked to RT assessments and feedback were limited to the evaluation of multiple-choice tests. More comprehensive approaches to automatic assessment, e.g., meaningful feedback, were largely lacking. However, in March 2023, Klett Publishing House launched the new reading tutor LaLeTu, which measures and promotes reading fluency with the help of AI [29]. According to information on the publisher's website, speech technology records and evaluates student reading samples in terms of reading speed, sentence stress, and reading errors. Allegedly, AI recognizes reading errors, long pauses, and incorrect intonations. It also has the capacity to recognize dialects and accents. With this technology, learners receive feedback while the teacher obtains an individualized analysis of reading performance. A playful reward system for reading motivation rounds off the offer. However, no studies have been published yet.

2.4. VR and Learning

For some time now, VR has been considered a strong contender in the world of learning technology. VR technologies are attributed to a high potential for generating added value in the context of learning applications. Studies have shown the positive effects of VR on learning [30]. The chances of improving teaching/learning processes through the use of VR are derived, among other things, from the high degree of immersion [31] that is achieved with these techniques, which can also address learners on an emotional level. The teaching/learning and the experienced environments merge, thus allowing learners to become immersed in the learning experience. At the same time, VR offers additional opportunities for interaction with the potential to improve individualization and flexibility of learning processes and strengthen cooperation between learners. Both aspects can be expected to provide strong arguments for initiating more successful and sustainable teaching/learning processes.

Although VR is still a relatively new technology in foreign language learning, it has been applied to this domain [32–34] mostly in the context of vocabulary learning and communicative processes training, which also fosters communicative skills. However, to our knowledge, applications at the school level that focus on training RF in a second language, do not exist. Nevertheless, two studies that used VR as a means to assess reading fluency have been carried out. In one recent study, Mirlaut et al. used VR glasses to assess beginner reading behavior and to measure their RF with the One-Minute Reading test [35]. While this study focused on native speakers, it showed that VR could be used as a legitimate tool for studying reading behavior in general terms [35]. As part of a master's thesis, the impact of reading in VR on a group of dyslexic student's reading fluency was explored [36]. The outcome of the study suggests that reading in VR may positively affect dyslexic readers, because it allows for the adjustment of fonts, text size, words per line, etc.

In general, applications of VR in school settings appear to be first and foremost linked to leveraging motivational aspects [37]. More comprehensive conceptualizations of learning scenarios linked to established methods in language learning at school and approaches for integrating classroom teaching with appropriate virtual learning methods appear to be missing thus far.

2.5. Technology-Acceptance Model

The perception of technologies can impact how these will be used in specific environments [38]. In this context, Davis et al. [39] developed the Technology-Acceptance Model (TAM) that was specifically designed to determine user acceptance of a specific type of technology—in this study: a VR application. According to Davis et al. [39], there are two key factors that could influence user attitudes and intentions to use a technology (see Figure 2): perceived ease of use and perceived usefulness. Perceived usefulness refers to whether users attribute added value to the technology, e.g., making training in reading fluency easier or more entertaining. Perceived ease of use is defined as the estimated effort that is required to use a specific technology. Since perceived ease of use and perceived usefulness are indicated as the most important factors influencing technology acceptance, they also play a central role in the context of this research.

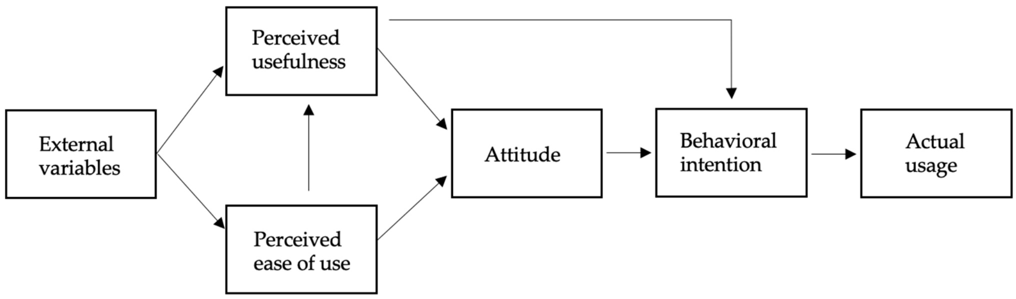


Figure 2. Technology-Acceptance Model (TAM) (our own illustration, based on Davis et al. [39]).

According to the model, the behavior of an individual is determined by their behavioral intention to use a specific technology. The behavioral intention to use a technology sheds light on a person's intentions to use it in the future [39]. Accordingly, users are more likely to accept applications that they find useful and are easier to use than those with little added value and complicated applications [40]. In the meantime, TAM has been used in a number of studies to examine attitudes towards new technologies [41]).

3. Concept and Design

3.1. Learning Objectives

The objectives behind the learning activities are, on the one hand, important for the development and promotion of good RF. On the other hand, these objectives were developed according to the general limitations and challenges of MELT, e.g., growing heterogeneity in classrooms [4], time restrictions for teacher feedback, and low motivation for reading aloud activities [28]. Therefore, with the implementation of MELT in a desktop VR school environment we hoped to develop the following: engaging, motivating reading tasks; personalized and intensified individual RF training and feedback options; and flexible collaboration opportunities for MELT in time and space. Based on these, the overarching learning objective for the desktop VR training session is for students to improve their RF by practicing reading scripts in a small group within the desktop VR environment. This is achieved by the following sub-learning objective in which students:

1. use the desktop VR environment to communicate and cooperate effectively with learning partners;

2. give and receive feedback on their performance of the text;
3. move through the desktop VR environment and interact appropriately with its features in order to improve their RF;
4. gain a deepened understanding of the story and its characters by interacting with props and images provided in the desktop VR environment.

3.2. Learning Scenario

Based on the learning objectives described in the previous chapter, the learning scenario of the desktop VR environment was developed.

3.2.1. Sub-Scenario of MELT Phases

For the implementation of the MELT concept in desktop VR, specific phases were chosen from the RF training concept. Based on the challenges of collaborative practice that occur in the classroom, e.g., limited spatial capacities at schools, certain phases of the collaborative RF training of MELT in particular were implemented in the desktop VR training phase and taken into account accordingly in the design of the desktop VR environment. This was conducted in an effort to address the challenges of traditional classroom instruction and to explore alternative design options for conducting MELT in VR. Thus, the focus was on the phase of collaborative RF training in various small groups of 3–4 students (n = 7). This correlated with phase 6 of the eight phases of MELT, as introduced by Kutzelmann et al. [20] (see Figure 1).

3.2.2. Desktop VR Concept (Implementation of MELT in Desktop VR)

To address the challenges of RF training in a classroom setting as described in the previous chapter, the desktop VR environment is based on the development of various virtual classroom types. For this purpose, a VR school environment was designed to consist of three large classrooms (see Figure 3a) and five small breakout rooms (see Figure 3b).

(**a**) (**b**)

Figure 3. Available rooms in the desktop VR school environment: (**a**) Example for one of the three large classrooms; (**b**) Example for one of the five small breakout rooms.

In general, all of the eight VR rooms should be used for collaborative reading fluency training, i.e., MELT script out loud reading and giving others feedback. The collaborative reading training could take place both in tandem and in small groups (with three to four students per group). In addition, the VR school environment also provides ample space to conduct individual practice periods in which each student practices the MELT script on their own. However, since this was not the focus of this study project, this aspect will not be addressed.

In addition to the overarching goal of collaborative reading training, the learners were given additional tasks in two of the larger classrooms and the smaller group rooms.

The main purpose of the two larger classrooms was to create a space where the whole class, or in this case the study participants and the teacher, could come together for two different reasons. First, to acquire specific instructions from the teacher about the RF exercises that will be carried out, i.e., the task to be completed, time to complete the task, and group composition. Second, students should gather into their respective groups, determine reading roles, choose, and familiarize themselves with an individual avatar.

In the third large classroom, student groups present their scene to one another and receive feedback from the teacher and classmates. This means that both a final rehearsal and a performance of the MELT script are to be carried out in this classroom.

The small group work rooms were also designed to enable collaborative practice in small groups. Since these small rooms can only be entered via a link that opens a new browser window, these serve primarily for undisturbed reading training space. This degree of privacy should also be used by teachers to give groups individual feedback about their RF performance in an unthreatening atmosphere.

3.2.3. Desktop VR Design

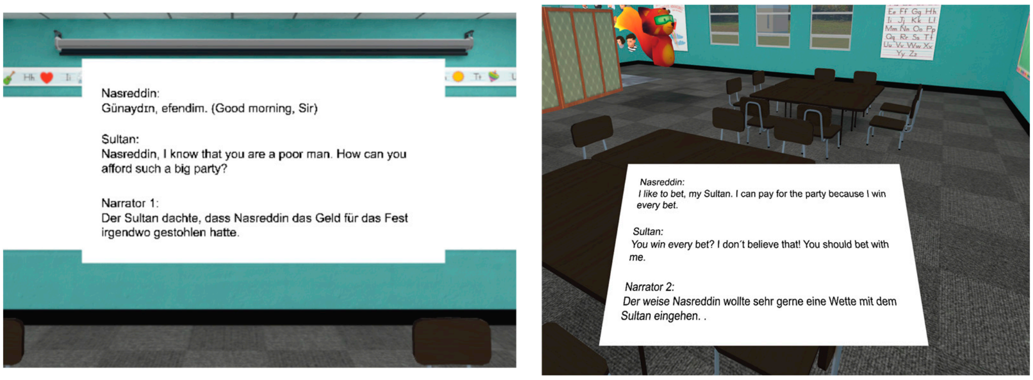
For the development of the desktop VR learning environment, a VR school model was used that had already been made publicly available by the selected VR software, Hubs by Mozilla. This model already represented a school environment with a total of eight different classrooms. To adapt the model to the specific needs of conducting MELT in desktop VR, some modifications were made based on the one developed by Hubs. Some of the tables and chairs were removed from the large classrooms while a stage and partition wall were integrated, and avatars, shelves with props, and the MELT theater script were added.

The following describes how the individual rooms were designed, based on the tasks and functions that should take place in the individual rooms.

Practicing reading aloud cooperatively: In order to enable cooperative reading training in the rooms and to offer the students a wide range of cooperation opportunities, all rooms were equipped with chairs and tables analogous to real classrooms. However, these were arranged differently, making it possible to be used for different reading tasks. One of the large classrooms was furnished with free-standing chairs that had a foldable backrest, while the other one had various group tables. In both large classrooms, a free area without chairs and tables was set up for free use in the front area. A stage was integrated into the third large classroom for the purpose of conducting final rehearsals and reading performances with the entire class. Hence, the chairs in this room were arranged in rows staggered upwards, which are analogous to a lecture hall or theater hall, thus allowing all students to have a good view of the stage.

The five smaller classrooms, on the other hand, were set up identically. The reason here is to create a pleasant discussion atmosphere for feedback and at the same time offer space for collaborative practice in smaller student groups. Finally, a small meeting table with six chairs was integrated into all of the five small VR group rooms.

To support collaborative reading, the RT scripts were directly integrated as digital versions into all of the eight classrooms. On the one hand, the MELT scripts were first uploaded to each classroom in advance by the study instructors and pinned on the available media walls (see Figure 4a). Secondly, each student was given the option of viewing the RT scripts as cue cards (see Figure 4b) which they "carried" with them through the environment as they moved their avatars. This provided students with flexible and space-independent reading training.



(**a**) (**b**)

Figure 4. Versions of digital MELT scripts in the desktop VR environment: (**a**) Example of uploaded VR script on media wall; (**b**) Example of MELT script on individual cue cards.

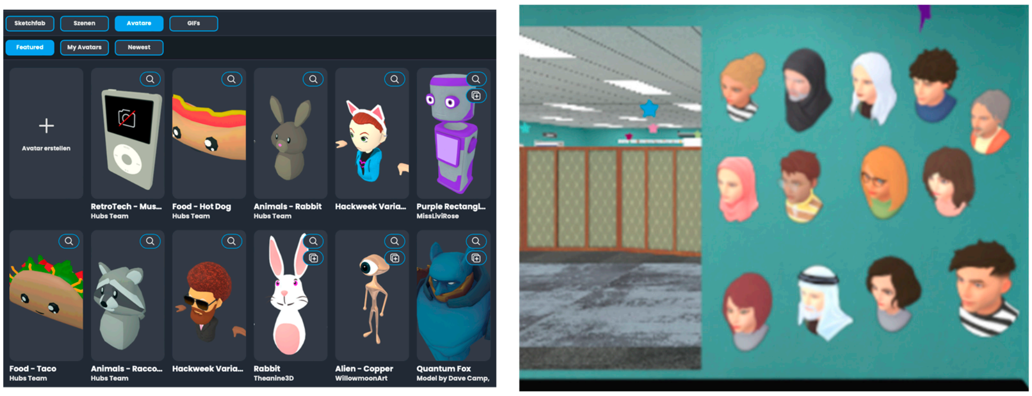
In addition, audio zones were set up for all of the rooms so that students could hear only each other within the same room. The closer students placed their avatars towards each other, the louder their voices became. This provided enough space for individuals and groups to practice at the same time, which was designed with individual student needs in mind. Additionally, the feature allows for the receiving and giving of feedback in a private and non-threatening atmosphere.

Support further understanding of story and characters in the MELT script: To improve the overall prosodic composition of student reading, it is necessary to have a literary understanding of the MELT scripts [28]. For this reason, various props in the form of 3D objects (see Figure 5a) were integrated into the desktop VR environment in order to visualize central elements. Students could use these during cooperative reading sessions in order to highlight the content of their script, to give more expression to their own role, or the content of the readers' theater. Furthermore, posters were also integrated into the environment that illustrated central elements, characters, and contents of the RT (see Figure 5b).

(**a**) (**b**)

Figure 5. Elements supporting the further understanding of story and characters: (**a**) Example of a 3D object that appears in the MELT script; (**b**) Example of a poster that shows the main character of the MELT script.

To support engagement with their roles and characters, students were allowed to choose a personal avatar. In addition to an internal collection of avatars provided in Mozilla Hubs (see Figure 6a), additional and pre-designed avatars were provided directly in the desktop VR environment (see Figure 6b). These were specifically designed to reflect the roles and content of the underlying MELT scenario. In order to spatially delimit the choice of an avatar from the reading training area, the back of one of the large classrooms. A mirror wall was also integrated into this area, which should enable the students to look at the avatars and become familiar with them since the field of view of the students represents a first perspective.



(**a**) (**b**)

Figure 6. Avatars supporting the further understanding of the characters: (**a**) Mozilla Hubs internal avatar collection; (**b**) Pre-designed avatars uploaded directly into the VR environment.

Asking for, giving, and receiving feedback: Due to the use of an avatar eliminating nonverbal behavior, such as e facial expressions and gestures, it is also important in VR that the students receive feedback on their expression and intonation while reading. To provide such feedback to each other, both auditory and visual options were made available in the desktop VR environment. Students could comment on how a classmate read aloud using two features that are provided in Mozilla Hubs. Students can either select an emoji from a dropdown menu or use a chat function. In addition, there was also the possibility of giving more detailed oral feedback. The smaller rooms were specifically designed for this purpose by offering a more private and unthreatening space than the large classrooms. This trains the perception of fluent reading and supports reading development.

Originally, the head of the study should have joined the VR environment by means of an iPad and avatar in order to coach students during the exercises (e.g., by giving feedback). However, this plan could not be realized due to technical problems.

3.2.4. Interaction Design

Since the students already use iPads in their everyday school life, this technology was selected for the study project in order not to overwhelm them with unfamiliar technology and VR software. In the following, the interaction design is described in relation to the use of the VR software on an iPad. The complete operation of the VR software was carried out using various tapping and swiping commands.

Avatar selection: By tapping once on the respective avatar, a button with the command "Choose an avatar" appears. By simply touching this button, the avatar could be selected and then automatically change its appearance.

Avatar navigation: The avatar could be moved forward by zooming in on the appropriate spot with two fingers. Backward movement is achieved by zooming out with two fingers. Swiping left or right rotated the avatar in those directions. Simultaneous movement and rotation could be performed using on-screen joysticks. With the help of these commands, one's own avatar could be moved through all rooms.

Seat avatar: To place the avatar on a chair, two fingers should tap simultaneously on the iPad screen and then select a chair.

Use of cue cards: Cue cards with the MELT text could be displayed by tapping the screen with two fingers and then selecting the magnifying glass icon. The entire MELT text was divided into different index card pages. Three roles were displayed on each index card page. After reading these, students need to manually switch to the next page of cue cards. This could be displayed by tapping the index card once. An arrow menu (left arrow (back one page) and right arrow (next page)) was then displayed, allowing students to navigate to the next cue card page by tapping on the desired arrow.

Prop usage: Props could be controlled by using a custom object menu that appears when tapping on an object. To rotate an object, the rotate icon is tapped while simultaneously specifying the direction by means of finger movement. Following the same principle, an object could be enlarged by holding the zoom-in icon and either moving the finger away from the object (zooming) or towards the object (zoom-out). While holding the object with a finger, it can be freely moved through the VR environment and shifted from one room to another.

4. Methodology

4.1. Study Design

The study was inspired by the idea of a design or feasibility study. The main purpose of the study was to conduct an initial assessment of applying MELT to the VR context. This evaluation could then serve as a basis for determining its potential applicability across different levels of the SAMR framework. It should be noted that while this study has predominantly addressed the substitution level and allowed for potential application at the augmentation level, it could also provide insights for further research, thus extending the implementation of MELT in desktop VR to the modification level and beyond.

The objective of this study was to investigate the acceptance and potential of MELT—a RF training format when performed by students in a desktop VR application. From this, design recommendations for future use of VR in the context of MELT should be derived. In this context, requirement surveys were conducted to analyze the challenges of traditional face-to-face instruction in foreign language classes, as well as the limitations of implementing MELT in the classroom. It was found that in implementing MELT in the classroom, and in particular, collaborative RF training in student groups, difficulties arose due to space limitations in schools and classrooms. For this reason, digital supplements are needed for flexible learning and facilitating the implementation of RF training, as well as collaborative RF practice. In particular, the study focused on testing collaborative RF training in various small groups (with three to four students each) (see Chapter 3.2).

The general approach was to ensure that the study design was as realistic as possible. It was therefore necessary to carry out the study design and collect data in a real school with real users, i.e., students and teachers. Moreover, the desktop VR study was carried out in the context of a MELT intervention in a real school. This means that the MELT concept was first explained to the students in the classroom. In this way, they became acquainted with and tried out all phases of MELT in a physical classroom setting. The collaborative RF training was the only phase carried out with a subset of the students in the VR environment. In addition, the study design relied on iPads, a technology that was already in use at the study school. The advantage was that the students were already familiar with this tool, thus making it easier for the students to participate in the study. Since the VR software was freely accessible via the Internet and did not have to be paid for separately, or installed on the iPads, it was possible to create highly realistic study conditions. As access to the environment is not location-bound, there is the possibility of including other schools, either nationally and/or internationally, in the training sessions, hence adding further potential for collaboration.

4.2. Subjects and Procedure

The study was conducted at a Secondary school in Ravensburg (Germany). Both the students and their parents were informed of the research project in advance. In order to participate in the interviews, a written declaration of consent was signed by both the parents and students. However, the students could independently decide whether to participate in the study or not.

The sample consisted of students (n = 28) in a bilingual English class in grade nine; the mean age was 14 years. Because the students had no prior experience with MELT, the study and data collection were preceded by two hours of classroom training (e.g., 90 min each) in order to introduce the students to the method. The two training sessions were, however, used solely for introductory reasons and were therefore not analyzed empirically. In total, the study consisted of two phases that built on each other (see Figure 7).

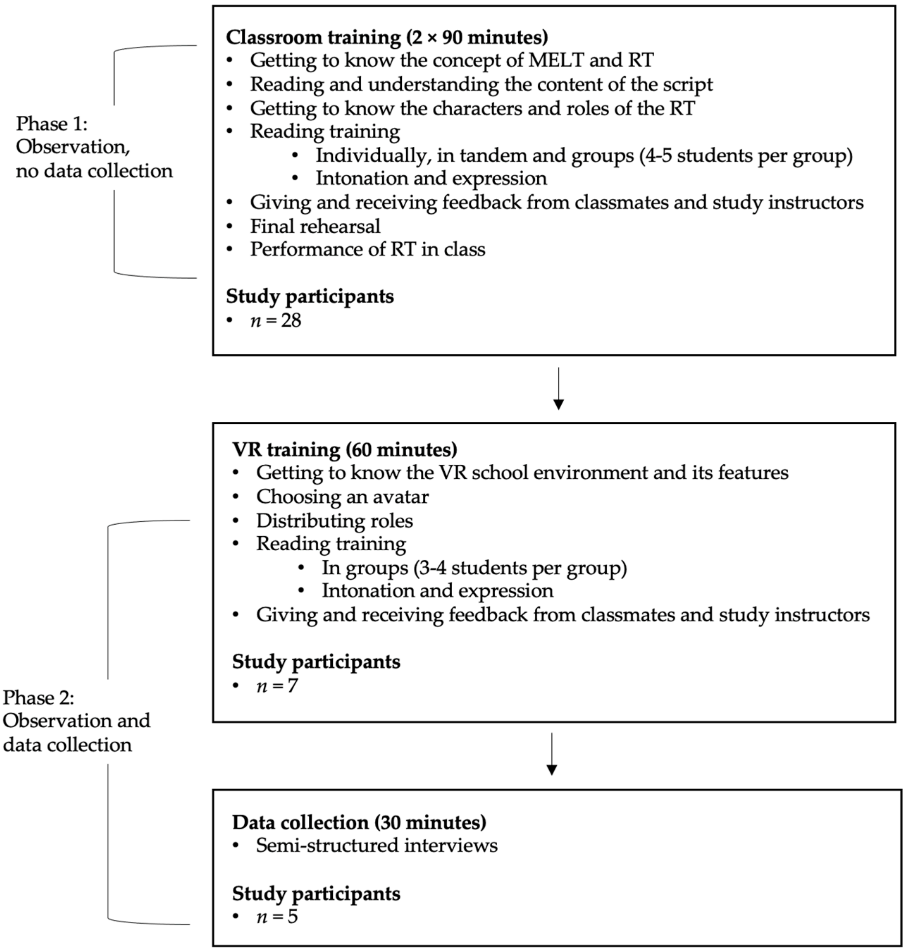


Figure 7. Study procedure (own illustration).

The study started with two synchronous classroom training sessions, based on the eight phases of MELT as introduced by Kutzelmann et al. [20]. Due to the limited time available, each phase was shortened to fit the timeframe of 90 min per session. The classroom training was conducted with the following learning objectives in mind:

1. Know the general concept of MELT;
2. Know and understand the story and characters in the MELT script (writing a table of consent);
3. Understand and learn the vocabulary used in the MELT script;
4. Practice reading the role aloud with others (e.g., intonation, emotions, etc.);
5. Give and receive feedback on group members' reading-aloud production.

The classroom training sessions took place in the students' classroom five and seven days before the VR study. All students attended these sessions during those two days. An overview of the contents addressed in classroom training can be found in Figure 7.

Following the classroom training sessions, those students who had completed the required declaration of consent (n = 7) participated in a synchronous desktop VR training session (60 min). First, as a group, all students were shown the desktop VR environment and its general functions (audio, chat, navigation, etc.) in the classroom (five minutes). However, the study itself took place in a different building where the school computer room was located. For this purpose, the students who were accompanied by the two study directors, changed buildings after the joint introduction in the classroom. There, the students were given the task of acquainting themselves independently with the VR environment by exploring its spaces and getting a feel for how to use and navigate it by means of an avatar (15 min). During the phase, each student was assigned an iPad (tablet).

After the self-exploration phase, students met in small groups to perform reading training, i.e., acting out or reading aloud one of the scenes of the MELT play. For the VR training session, only one phase of MELT was applied: the collaborative RF training. The previous phases (i.e., getting to know the play) had already been covered in the classroom training, at which time, they chose an appropriate avatar and met with their group which consisted of three to four students. The students were then given time to decide on which practice room to choose, and whether and how to integrate props into their reading training. Subsequent phases of MELT (such as the performance of the MELT script) could not be realized due to time constraints.

While students were engaging in the desktop VR activities, two study directors observed and noted their actions with guided, structured observation notes aimed at identifying aspects concerning RF, repetition, motivation, collaboration, and communication within the reading groups (see Chapter 5.2). After the activities were completed, some students (n = 5) were asked to provide additional qualitative feedback. One of the study directors conducted semi-structured interviews with five students that elicited the extent to which these students accepted the implementation of MELT in the desktop VR school environment and their reasons.

4.3. Investigation Tools

4.3.1. VR Software

There are various software applications that could be used to create VR environments for specific learning scenarios [42]. In the context of this study, we used the Mozilla Hubs platform [43], which features the creation and usage of virtual 3D rooms to facilitate various communication scenarios, in educational contexts. Mozilla Hubs is a web-based application that works on a browser and supports many devices. It can be used for a fully immersive experience with head-mounted displays, as well as for 2D web browser applications (e.g., desktop, laptop, smartphone, or tablet). The Mozilla Hubs rooms are private. Participants can enter a specific room by clicking on a web link generated by the room creator. The advantage of Mozilla Hubs is that it does not require further software installation. This particular ease of use was one of the reasons why we chose this application [44]. In addition, we selected Mozilla Hubs because of its free usage option for up to 10 users at a time, addressing concerns and risks of using VR in an educational context or class [45]. The restriction to 10 simultaneously active users did not represent a limitation in the context of the study, as training sessions with individual Reading Theatre Learning groups consisted of fewer students. It should be noted, however, that a regular implementation in class with possibly several parallel exercise groups therefore may require a modified solution with regard to the VR system to be used, but also possibly more comprehensive didactic measures that enable sufficient coaching of the different groups. Users are represented as avatars that they can choose from a large selection of pre-generated avatars. It is also possible for users to create an avatar with 3D modeling tools such as Blender. Further Mozilla Hubs features include display and media sharing (e.g., PDFs, images, videos, audios, 3D models, etc.), voice and text chat, and live reactions via emojis, among others.

4.3.2. Observation Notes

Observation notes were taken during the desktop VR training session by the two researchers who sat in the room with the participants. For a systematic recording of observations and subsequent comparability between the different observers, an observation protocol was developed with the following categories (see Appendix A): reading repetitions, reading of the RT script, design of the practice phases, communication within the groups, avatar and props, avatar movement and navigation, technique, and other notes/observations.

4.3.3. Construction Interview Questionnaire

In addition to the observation notes and to answer the research questions, additional, semi-structured interviews with the students were conducted that directly followed the desktop VR exercise phase. Overall, the interview guide was divided into four parts: (1) demographic information, (2) acceptance of the desktop VR RT (perceived ease of use and perceived usefulness), (3) effects of the desktop VR RT (joy, motivation, first impression) and (4) behavioral intention to use the desktop VR RT. The first part served to collect demographic information (1), consisting of a total of four questions about the students' media consumption ("*What technical devices do you own?*", "*How and for what purpose do you use media in your everyday life/at school?*") and previous experiences using VR applications ("*What has your experience with VR applications been like?*").

Interview section two analyzed student acceptance of the VR school environment (2) and the implementation of the RT in this environment. While the questions were based on Davis et al. [39] original Technology Acceptance Model questionnaire, their content was adapted to the specific format of the RT in the VR school environment and translated into German. As postulated by Davis et al. [39], student acceptance was therefore divided into perceived ease of use and perceived usefulness. The six questions about perceived usefulness were primarily related to the practice phase, reading tasks, and or the use of an avatar during the performance of the RT in the VR environment ("*What did you like/dislike about the VR practice phase?*", "*What did you like/dislike about the VR practice phase compared to face-to-face practice?*", "*How did you feel about performing the reading practice tasks in VR?*", "*What was easier/harder about performing the reading exercise in VR than in presence?*", "*What did you find helpful/disruptive about the VR environment in order to complete the exercise?*", "*How did you feel about being able to step into your role in the play with an avatar?*").

The four questions on perceived ease of use focused primarily on the VR school environment and how students interact with it ("What did you like/dislike about the VR school environment?", "What did you like/dislike about the VR environment compared to face-to-face practice?", "How did you get along with the VR school environment?", "Were there any (technical) problems during the reading exercise in the VR school environment, if so—which ones?").

The third part of the questionnaire was related to what effects (3), e.g., general impression or joy, the implementation of the RT in the VR school environment had on the students ("*What was your first impression of the VR environment or practice phase?*", "*How much did you enjoy today's practice period in VR compared to the practice period face-to-face?*", "*Did you feel more like practicing the play in the VR environment than in presence? Why?*").

The last interview section was to delve deeper into the reasons why students enjoyed using VR at school/in foreign language classes/in relation to RT, or not (4) in the future ("*What do you think are the advantages/disadvantages of performing a reader's theater in VR compared to being present?*", "*Would you like to use more VR applications in school/foreign language class/in relation to RT in the future? And why?*").

4.4. Methodology of Data Evaluation

4.4.1. Evaluation Procedure Observation Protocol

The observation protocol was completed individually by the two study directors following the desktop VR training session. Subsequently, the two observation protocols were compared in order to identify similarities or differences in the observations. The subsequent qualitative evaluation was carried out according to the previously discussed observation criteria.

4.4.2. Evaluation Procedure Interview Questionnaire

The interviews were subsequently evaluated by means of a qualitative content analysis in accordance with Mayring and Fenzl [46]. For this purpose, an iterative process was used to create a coding guide in the form of a category system with the following characteristics: main category, subcategory, definition of the category, and anchor example from the interview materials (see Table 1). The categories were formed both deductively along previous research findings and theories in the literature and inductively from the existing data material. The entire data material from the five interviews was analyzed with the help of this category system. Individual interview passages were assigned to the various categories in several iteration loops until a suitable category was found for all interview statements.

Table 1. Excerpt from the coding guide.

Main-Category	Sub-Category	Definition	Anchor Example
Effects of the VR RT	First impression of VR environment	In this category, study participants report on their first impression of the VR environment.	"I thought it was really good." (I. 1).
	Sense of fun and motivation	This category includes statements that relate to anything the study participants say about their motivation and enjoyment in using the VR environment or performing Reader's Theater in the VR environment.	"So it was even more fun." (I. 5).
Perceived Usefulness	Choice of an avatar	This category includes statements in which students comment on the choice and use of avatars in the VR environment.	"I just wanted it to fit my role a little bit. And because there were so many options to choose from, it was also good." (I. 3).
	Expression of emotions	This category includes statements related to the expression and perception of emotions when performing RT in VR.	"Disadvantage is just clear that you cannot hear these emotions and so good out." (I. 5).

5. Results

5.1. Description of the Sample

A total of $n = 7$ students participated in the desktop VR training session. Their behaviors were included in the observation protocols. Of these, four participants were female, and three participants were male. Only five of these students (four female and one male participant) participated in the interviews that are referred to in the following sample description. The average age at the time of the interviews was 14 years.

Use of technical devices in everyday life: With regards to the use of media in everyday life, it was found that participants use cell phones ($n = 5$), laptops ($n = 3$), tablets (e.g., family tablet) ($n = 2$), PC ($n = 1$) and TV ($n = 1$).

Use of technical devices in school: Three of the participants stated that they use their iPads at school.

Estimated duration of technical devices used per day: In terms of daily cell phone use, $n = 2$ students reported a daily duration of approximately two hours, $n = 1$ two to three hours, and $n = 1$ three hours. One student emphasized that her daily cell phone use had a fixed limit. In terms of daily iPad use at school, $n = 2$ students spoke of needing and using it for most of the school day. One study participant indicated that iPad use varied by subject, which approximated one to two hours per day. Overall, n = 2 of the students estimated their daily media use to be about three to four hours.

Previous experience with VR and VR environments: All participants (n = 5) reported having prior experience with various VR applications. While one student claimed never having been in a VR environment, 3 students named a school project that involved a VR art exhibit. One student talked about having used VR outside of school, two to three times at a friend's home. Finally, 2 students reported previous experience with VR glasses.

5.2. Observation Protocol

During the virtual reading training, the study participants were observed by the two study directors who used a guided, structured observation protocol with nine observation categories. The results are described below along these nine observation categories.

Reading repetitions: During the first reading of the RT scene in desktop VR, the students had trouble assigning the different RT roles and finding the appropriate page in the scripts while they read aloud in groups. As a result, the students would point out a missed cue, by saying "it's your turn". The second reading of the RT scene went smoothly.

Motivation to read: The students felt were motivated to read. It appears that they were more motivated during the desktop VR reading training than their classroom training. For instance, after the technical problems were solved, the students started to read the play on their own without being directly asked to do so by the study instructors. In presence, on the other hand, the students tended to occupy themselves with other things after a while. In addition, all students in a reading group had to take on a role unknown to them and read out unknown sentences. One student even had to take on two roles at the same time. The students had no inhibitions reading an unknown text and were motivated to read them. In addition, similar group dynamics with respect to reading motivation were evident in the desktop VR training as well as in the classroom training. For example, one student who motivated his group to read in presence also did so in VR. Reading motivation was also evident by the fact that the students did not take breaks during the reading training. After completing the first reading session, one group asked the study leader for the next reading task. In the physical classroom setting, the students did not ask the teacher for new tasks during the practice periods.

Reading Fluency: In terms of students' RF, no (positive/negative) differences were perceptible between the reading training in the desktop VR school environments and the classroom training sessions.

Communication & collaboration: At the beginning of the reading training in the presence, the students sat down next to each other and talked "in person" in order to distribute or discuss the division of the RT roles. This occurred above all when the first technical problems arose. After the technical problems were fixed, one reading group spread out on different floors in the hallway of the real school building while the other group spread out in a classroom to practice reading in presence.

Degree of distraction: During the reading training, most of the students were focused on their reading tasks and scripts. Only one student moved through the desktop VR environment with his avatar while his group members were reading, but then felt he had been caught by one of the study instructors.

Digital RT script: The study instructor first showed the students how to view and use the digital RT script in the desktop VR environment: i.e., how to keep clicking on the text shown on the media walls and how to view it on index card form. Even during the reading, some of the students needed help with setting and displaying the script. Nevertheless, all students voluntarily used the RT script available in the VR environment rather than their analog paper scripts.

Use of avatars and props: The study instructors observed that the students do not position their avatars in any special way while practicing reading. Instead, the avatars were randomly spread out in the room instead of being placed next to each other while reading.

This behavior resembles the RT reading practice in the presence where the students tend not to stand in any specific way, either. Even while reading per se, students did not move their avatars. With regard to the use of props during the reading training, students were observed to be aware of the props (e.g., by talking about them in their respective groups) but did not explicitly integrate them into the reading exercises.

Movement and navigation: The students intuitively and independently moved around and explored the environment and their features with their avatars immediately upon entering the desktop VR environment. This they were observed to do even without specific instruction from the study leader or an official warm-up phase that did not take place as planned due to technical problems. It was not apparent that the students had any inhibitions or fears about using the VR environment for reading practice.

Technical Equipment: The reading training start was delayed by audio problems in which the volume was too low so the students only partially heard themselves reading while their group members heard nothing at all. One student showed some frustration in this issue. In addition, Wi-Fi connection problems and the performance of the Internet in the school meant that students were forced to contend with re-accessing connectivity after being thrown out of the desktop VR environment. This problem meant an overall loss of reading practice time. In spite of this issue, the students remained motivated and patient while waiting for the technical problems to be resolved, or they searched for possible solutions themselves. Even though this took approx. 30 min, the students then became involved in the planned reading training which they carried out.

5.3. Interview Results

5.3.1. Student Acceptance of the Desktop VR RT

When analyzing interview results of the students' acceptance of participating in the virtual MELT, a distinction could be made between perceived usefulness and ease of use, as postulated by Davis et al. [39].

Perceived usefulness:

Choice of an avatar: Four of the five interviewees liked having the freedom to choose their own avatar. Two participants positively evaluated the variety of choices allotted to them. Various reasons were listed which were decisive for the choice of one's avatar. These were determined in accordance with the role in the RT play, personality, and the appearance of the avatar (e.g., "*what I find cool now*", I. 4). In addition, one person said that the choice of avatar made it easier for her to identify with her reading role.

Reference to the RT play and use of props: For one student the use of props for the reader's theater play in the VR school environment was evaluated positively. Conversely, one student claimed not to have used any of the props in the desktop VR reading training.

Reference to the RT role: Contrasting results emerged with regards to the students' reading in the RT play on the desktop VR environment. One participant reported that she found it easier to gain entrance into her RT role in presence because she was able to draw more parallels to acting in a theater (e.g., voice changes), while another participant said it was easier for her to change into her role because of her avatar choice.

Spatial flexibility: Three of the study participants talked about how they liked the flexibility of the desktop VR environment which made it possible to read together without having to sit in the same room.

Level of variety: All five participants told us that they found conducting the MELT in a desktop VR environment to be very diversified in relation to their usual school day routine and that they liked this very much. One student went on to describe this aspect as follows: "*Because it's just something new and you don't do it every day. . .*" (I. 5).

Expression of emotions: With regard to the expression of emotions while reading the MELT script, differentiated results could be observed. Two students reported that it was more difficult for them to express their emotions and hear the emotions of other students when reading in VR than when reading in presence. The reason for this was the representation of oneself in the form of an avatar cannot show a facial expression. However, another student went on to say that there are no significant differences: "*I don't think it's a big difference. You can tell that other emotions are also shown whether you're standing opposite each other or there's another device in between.*" (I. 3). In contrast, one student perceived emotions better when reading in the VR school environment than in presence.

Immersion: The statements by three students show that they experienced feelings of immersion during the reading training or in the desktop VR environment in general: "*It almost felt a bit like you were really in there*" (I. 1). Another student gave credence to the feeling of immersion as follows: "*It felt a little bit like being in school*" (I. 2).

Perceived ease of use:

Movement, navigation, and orientation: Two students stated that they could move freely and enter different rooms by means of their avatar in the desktop VR environment. Another participant reported needing time to learn how to navigate by avatar at the beginning of the reading training in the VR environment. However, he only needed three to five minutes to become accustomed to this function which worked well. One of the participants reported frequent navigation problems, in which her avatar became stuck to the environment furniture (e.g., a chair). This participant also referred to differences in the field of vision in the VR environment as compared to the real world, saying: "*You couldn't see exactly what you normally see, so you had to adjust to what you see a bit first*" (I. 5).

Degree of distraction: Four of the five participants stated that the VR environment did not distract them from the reading training and exercises. One student attributed this to her frequent use of an iPad at school. Another student justified this by saying that she focused mainly on the script and not the surroundings in the VR school environment while reading and practicing.

Digital RT script: Three of the participants perceived the presence of a digital theater script both on the media walls and in index card form positively. One of the participants explained as follows: "*It's not so boring with the paper at the front, but you can have it at the bottom, press on nicely*" (I. 2). Likewise, three of the study participants reported problems in using the digital theater script because one "*...always had to press on a cross at the top, so it wasn't so easy to see when it was your turn*" (I. 2).

Desktop VR school environment Design: Comments by four study participants concerning the design and structure of the VR environment were consistently positive. They found the virtual school building and the various classrooms to be realistic. The large number of classrooms surprised two of the study participants who said the school building and classrooms were a good representation of their real-life school. In addition, one of the interviewees commented specifically on the furnishings, which she claimed were "*...very colorful and um clearly arranged*" (I. 5).

Communication & collaboration: Communication and collaboration within one's group during the desktop VR reading training was described as difficult by two participants. They reported occasional difficulties with understanding the other group members which was mainly due to audio problems. Moreover, due to the use of the digital RT scripts, it was not always clearly recognizable whose turn it was to read next. The ability to hear and understand the other group members directly in the VR environment, as long as there were no audio problems, was found to be positive by two interviewees.

Degree of exercise/reading difficulty: Two students found the reading training in the desktop VR school environment to be more difficult than reading in presence. The reasons were as follows: technical problems, use of a digital script, and expression of emotions. One student, on the other hand, stated that she did not find the reading training in the VR environment more difficult than in the presence.

Technical problems: One of the participants said that it was difficult to hear the other group members at the beginning of the reading training. Towards the end of this phase, however, the volume problems could be solved, as she explained. With regard to audio-technical aspects, one study participant noted finding it "stupid" that most of the study participants did not have headphones with them. Two students also talked about how the time they were able to spend in the desktop VR environment was limited as a result of problems with the WIFI connection in the school building. These complications were evaluated differently by two students: One student said the technical problems were "*...not particularly bad now*" (I. 5), while the other felt it was "*...just a little bit stupid that it did not work out so perfectly then*" (I. 3).

5.3.2. Effects of the Desktop VR RT

The general impression of the Desktop VR environment (usefulness, ease of use, design) and the reading fluency training: Four of the five participants responded positively about their first impression of the VR environment and the reading exercises. They described it as: "*I thought it was really good*" (I. 2) or "*...it was cool*" (I. 3).

Sense of fun and motivation: Three of the five interviewees said they liked practicing the RT play more in VR than in presence. In addition, three interviewees also talked about how much more they enjoyed reading in the VR school environment than in the presence. One person, on the other hand, stated that she did not enjoy reading in VR any more or less than in presence. Moreover, she would prefer to use either format or a combination of both.

5.3.3. Behavioral Intent (Future Usage of Desktop VR RT)

Potential of RT in Desktop VR: All participants stated that they could imagine learning more in the future with VR applications because it is fun and offers variety. Of these, two of the interviewees specified that they would not want to use VR exclusively in class, but rather as a change from normal school lessons e.g., two to three times a month, or as a combination of both. As one participant put it: "*Well, I think it's best to have both together somehow*" (I. 3). In addition, one student said that he could imagine using VR, especially in English/foreign language classes, e.g., to learn and test vocabulary, engage in role plays, or read texts.

6. Discussion and Conclusions

Reading training formats that promote RF, e.g., repeated or assisted reading, are considered to be time-consuming. They often do not allow teachers to respond to the individual needs of students, nor give sufficient feedback. In addition, it is very difficult to motivate students as they sometimes find reading-aloud activities monotonous. Therefore, the overarching goal of this study was to determine the extent to which students accept the implementation of a specific phase of MELT in a VR environment for the purpose of cooperative reading fluency training. This may aid in increased efficiency, easier structuring of personal learning processes, individual feedback options, online collaboration, and a more satisfying and motivating user experience for the students.

In this section, we will now discuss how the learning objectives established in Chapter 3.1 could be implemented through the design of the VR environment and the didactic structure of the desktop VR training session. With regards to the sub-learning aim of providing opportunities for cooperative reading training, an important and surprising finding in this project is the overall positive response to the virtual RT, despite numerous technical difficulties at the beginning of the VR training session. In addition, the students indicated that they felt highly motivated and had more fun during the virtual RF training than during the face-to-face reading training (s. Chapter 5.3.2). However, two students explicitly stated that reading training in desktop VR was still more difficult for them than in presence, mainly due to technical challenges. Furthermore, the students perceived the presence of the digital MELT script as positive, even though they described its use as challenging and complicated (s. Chapter 5.3.1). In terms of testing the use of MELT and making student collaboration easier in VR, alternative possibilities should be created (e.g., the digital representation of the MELT script). In addition, the VR software that enables the reading text to be displayed and operated more easily should be tested.

Turning now to the second sub-learning objectives, (e.g., methods to encourage the giving of and receiving feedback), results showed that students did not use the chat and emoji features, even though they discovered them of their own accord. Due to the omission of non-verbal communication elements such as facial expressions or gestures, students are not able to interpret fellow readers reactions to their reading performance. In this context, it would be important to help students understand the relevance of giving and receiving verbal feedback about reading fluency as a means of support. In addition, various exercises should be integrated into the collaborative reading fluency training phases of VR. In this way, students can be instructed on not only how to give each other feedback, but also to encourage them to do so. For example, students could also be motivated to give feedback by means of a gamified approach, (e.g., a virtual badge award to the group that gave the most feedback).

Analysis of data concerning the third sub-learning objective that allows for movement and interaction within the desktop VR environment revealed that after initial difficulties and a short familiarization phase, most students were able to move their avatars around well. However, this feature distracted some of the students from the exercise task at hand, which then enticed them to continue exploring the VR environment and trying out the functions, (e.g., sitting on a chair, etc.). After a short introduction, they were also able to independently and intuitively use the other VR features (e.g., the digital MELT script). This ease of use is likely the result of their daily media use and, or prior VR experience (s. Chapter 5.2). However, it is unclear whether this ability improved their RF. This would require further experimental studies.

We now turn to the fourth sub-learning objective of gaining a better understanding of the story and its characters by means of interacting with props and images. Interview results showed that students very much liked how the design of the desktop VR environment was based on the content of the MELT script through the use of relevant props, even though they did not actively integrate them into their reading training. The free choice of an avatar was also described positively. However, only one student was able to benefit from the avatar that helped her identify in her role (s. Chapter 5.3.1). It is therefore recommended to integrate student input more into the design and development process of VR environments (e.g., avatar creation). This has the potential to promote learner discussion, as well as to support the process of understanding the MELT script content. In addition, there are a plethora of other features that could be integrated into a VR environment. For example, features that focus on practicing and improving RF are aimed at increasing student acceptance of VR or supporting students in giving and receiving feedback. Teachers and students would certainly benefit from functions similar to a recording studio that allow for uploading and recording audio files. In addition, an audio studio could also include a vocabulary pronunciation feature. Functions that support independent reading training could be integrated along with a comment function. Finally, integrating vocabulary lists would certainly add to the desktop VR environment learning experience.

Those factors associated with perceived usefulness, e.g., avatars, MELT content-specific environment design, and spatial flexibility of the VR environment, were perceived as useful and varied. However, a majority of the respondents found the expression and perception of emotions in the VR environment to be more challenging than in the presence (s. Chapter 5.3.1). To deal with this issue, students could benefit from instruction on and practicing the means to express emotions in the VR environment through intonation and voice pitch. In addition, when training in presence, one could create similar conditions for practicing the expression and perception of emotions as they occur in presence. For example, with closed eyes, students could listen to their classmate’s expression of emotions with special emphasis on the emotions of their MELT character. An interesting paradox with regards to the perceived ease of use of the desktop VR environment emerged. Despite the difficulties with the digital script and various audio problems, students found these integrated features to be positive. It was not possible to carry out pre-tests under real study conditions within the scope of this study, due to limitations of time (i.e., hardware and software testing in advance with real study participants). For future studies, it is advisable that pre-tests are planned for and carried out in order to identify and eliminate technical problems early on. In this study, it was only possible to test the functionality of the hardware and software with one person in advance. Unfortunately, this was one of the study leaders. It would have been more advantageous to include a real number of study participants in this process. In addition, it is advisable to carry out the study with several study managers who can support participants in the event of technical difficulties.

In summary, an important and surprising result of this project revealed that despite numerous technical difficulties at the beginning of the desktop VR training session, the students' first impressions of the virtual RT were highly positive. Moreover, they indicated being highly motivated to engage in the activities and that they had had more fun as compared to face-to-face reading training (s. Chapter 5.3.2). In particular, due to the high levels of motivation and patience among the study participants, it can be concluded that they accepted the implementation of MELT in the desktop VR school environment. This aspect is consistent with previous research results and findings in the literature (see Chapter 2.4) [30]. This finding also suggests that with the above-mentioned improvements, the use of VR applications could potentially enable numerous design options, such as self-learning activities, personalized learning, and feedback, which are difficult to achieve in face-to-face settings. The results here provide evidence that supports the potential of the MELT reading fluency practice phase in a VR environment. Moreover, the findings suggest that the refinement and transfer of an established format for training reading fluency, such as in this project, creates additional added value that can, among other things, counter the limitations of the setting itself (e.g., the low motivation of the students to practice reading repeatedly).

In view of the limitations of this study, it must be stated that due to the time, financial, and personal resources available, an unrepresentative study was carried out. It should be noted that this study served as a pilot with a small sample size ($n = 7$). Moreover, we were unable to analyze speech patterns, nor the number of spoken words due to data privacy and technical constraints. Audio recordings were not permitted, thus preventing us from conducting an analysis of the aspects mentioned above. However, we do plan to address these dimensions in the future.

With regard to further research in this area, it is therefore essential to conduct a long-term study with a representative number of students in order to be able to draw more robust conclusions about their acceptance of the reading fluency practice phases of MELT in a VR application and RF development over a longer period of time. In addition, it is essential to test the various RF training phases and formats of a RT (e.g., individual, tandem, group) in order to assess how these affect student acceptance. It would also be exciting to explore the final performance of the MELT script in VR. In order to draw conclusions about the promotion of reading fluency in VR, an experimental study design would have to be carried out.

The above results can be considered a first evaluation of the acceptance of VR technologies in the context of reading fluency training at schools within the specific scenario of MELT. The next steps in this research will include a more comprehensive implementation of a VR-enhanced MELT scenario at schools and a more comprehensive evaluation over a longer time period, hence allowing for more informative insights on the possibilities and potentials for a permanent application of VR technologies in this context. Since the study results revealed the potential for the substitution and augmentation levels of the SAMR framework, further research will explore how modification of and even redefinition can be achieved by integrating MELT and VR technology. Corresponding research activities will also investigate the influence of specific VR technologies (e.g., VR glasses), as well as usability aspects and user experience in more detail. Link original VR school environment: https://hubs.mozilla.com/5JAX6Qa/ready-hidden-area (accessed on 1 September 2023). Link customized VR school environment: https://hubs.mozilla.com/link/EqYFJmf (accessed on 1 September 2023).

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Data Availability Statement: The data presented in this study are openly available in RADAR at https://doi.org/10.22000/1729 (accessed on 1 September 2023).

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Appendix A

Main Category	Sub-Category	Observations
Turn Takings	Number	
	Smoothness/speaker overlaps	
	Repetitions	
	Missed cues	
Arrangement of practice phases	How often and how much is read/practiced?	
	How often are breaks taken?	
	Do students focus on practicing or are they otherwise engaged/distracted (with surroundings, etc.)	
	Do students finish before/after the given time?	
	Where do the students read their speaking text from?	
Avatar & Props	How do the students move/position their avatars in the environment? (Proxemics)	
	To what extend do the students use props/features of the environment?	
Technology	To what extend do (technical) issues arise? (audio-/image quality, WIFI problems, performance/speed of the tablet)	

Figure A1. Observation Protocol (Translated from German).

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