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Research Article

LitSpatz: An App for Literary Walks to Promote and Record Primary Students' Text Comprehension, Perspective Taking and Related Skills

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Abstract: Teaching listening and reading skills including abilities to adopt spatial and affective perspectives of literary figures and to reflect critically on texts regarding one's own world are central goals of primary school education in Germany, Europe, and beyond. However, many primary school students fail to achieve minimum standards in these skills. To support students in developing these skills and to record their current skill levels, the *LitSpatz* application was developed. It refers to previous findings on children's cognitive and affective-motivational development, approaches of effective reading instruction, and selected approaches of geographical education. Within this app, primary students are offered the opportunity to take part in literary walks through the city of Bamberg (Germany), either on-site or off-site. Therein, a walk-in story is presented auditorily. Furthermore, illustrations or references to authentic locations are displayed to visualize the scenes' settings and cognitively activating and further questions are asked. The study aims to present the app and initial evaluation data from its use in virtual literary walks (off-site) by children (N = 52) in reading classrooms. In particular, students' characteristics and abilities in relation to text comprehension and aspects of perspective taking (spatial and affective perspective taking, transportation, empathic text comprehension) are explored. Additionally, findings show high levels of listening motivation and enjoyment when using the app. Experiences and results from the use of the app are discussed with respect to future steps regarding its use on-site, the evaluation of its impact, and possibilities for implementing further geospatial technologies.

Keywords: text comprehension; spatial and affective perspective taking; reading and listing motivation; walk-in story; primary students

Highlights:

- Development of the *LitSpatz* app as a tool for promoting and recording students´ text comprehension and related skills.
- App enables primary students to participate in (virtual) literary walks to achieve learning goals in listening and reading.
- Preliminary results on students' text comprehension, related skills and enjoyment in using the app in classrooms.

1. Introduction

According to the educational standards in Europe (Council of Europe, 2020) as well as the curricula in Germany (KMK, 2022), teaching skills in speaking, listening and reading are central objectives of primary school education. Concerning text comprehension in reading and listening, these educational goals also include teaching the skills required to build mental representations, i.e., *situation models* (e.g., Kintsch, 1998). Based on the German curricula (KMK, 2022), students are expected to learn a variety of skills while reading. First, they should develop an understanding of the plot, the characters as well as the spatial and temporal elements of literary texts. Second, they should adopt and distance themselves from the perspectives of literary figures. Third, they should elaborate texts and critically reflect on their content in relation to their own surrounding lifeworld, experiences and prior knowledge. Finally, according to educational recommendations (KMK, 2022), these skills should be taught and practiced using a variety of media, including digital media (KMK, 2022), which have rarely been used in this context in German reading classrooms to date (AG Bildungsbericht, 2024).

As international large-scale studies, e.g., the *Progress in International Reading Literacy Study* (PIRLS; e.g., Mullis et al., 2023), and regular national assessment studies in Germany, e.g., the *Internationale Grundschul-Lese-Untersuchung* (IGLU; International Primary School Reading Survey; e.g., McElvany et al., 2023) repeatedly have shown, many primary school students do not meet the minimum educational standards. For example, according to recent studies in Germany, around 18% of all primary students do not reach the minimum standards in listening (Stanat et

al., 2022) and around 25% do not reach the minimum standards in reading (McElvany et al., 2023), which is particularly true for students from socially disadvantaged or foreign-language backgrounds (e.g., McElvany et al., 2023). Furthermore, the literature on reading literacy has, so far, only provided a limited number of findings on the spatial and affective perspective taking skills of primary school children in the comprehension of literary texts. However, results on the mental spatial representation skills of primary school students – although not on their adoption of spatial perspectives of literary characters – can be found in studies on geography education. For example, Zisi and Klonari (2022) have shown that children of pre-school age already exhibit deficiencies in spatial abilities.

Against this background, there is a strong need of support for many primary school students to improve their listening and reading skills. Furthermore, there is little research on the development of spatial and affective perspective-taking skills and their relationship to text comprehension. Both needs are addressed in the project presented here, in which the *LitSpatz* application was developed and implemented for the first time. In this app, a walk-in story with six scenes set in the city of Bamberg (Germany) is presented auditorily and the locations of the scenes are visualized via illustrations or instructions for viewing the authentic locations on site. Additionally, after each scene, cognitively activating and further questions on text comprehension in a multiple-choice-format are asked. The app is usable on-site with mobile phones or off-site with electronic devices with internet access. It enables primary school students to take part in a (virtual) literary walk, i.e., listen to the story, see the story showcases and answer the accompanying questions. Hence, one objective of the project is to provide children with a digital offer to promote their listening and reading skills. In addition, the project seeks to investigate these skills including rarely explored abilities and characteristics related to text comprehension of the students, such as spatial and affective perspective taking when listening to a story with presented illustrations versus authentic settings. To achieve these goals, the project builds on previous studies on readings in classrooms (Heyne & Hermann, 2024) as well as on the research findings introduced in the next chapter and transfers these approaches to the LitSpatz app, which is introduced and piloted in this study.

2. Literature Review

The conception and the development of the app refers to various assumptions and findings from previous research. These include assumptions and findings 1) on the cognitive development in primary school age as well as on the development of text comprehension skills, 2) on the emotional-motivational development of primary school students from a developmental psychology perspective, 3) on instruction and media for teaching speaking, listening and reading skills, and 4) insights from geographic education. A selection of these underlying assumptions and findings are outlined in the following.

Regarding the cognitive development of children of primary school age, early studies assumed that primary school students fail in abstract thinking but have abilities in concrete-operational thinking (Piaget & Campbell, 1977). Accordingly, for children of this age, thinking is characterized by the fact that the processes of reflection and understanding relate to concrete and potentially observable and manipulable objects. Children's text comprehension and the formation of adequate situation models could therefore benefit from relating the story to concrete and tangible spatial settings. Similarly, according to the embodied cognition approach (Glenberg & Galese, 2012), language and thinking skills are thought to develop in acting with and while behaving in the context of the corresponding objects. Consistent with these assumptions, results showed that children as young as 7 years of age showed better results in spatial imagination and especially in the development of flexible mental representations of places when they had the opportunity to explore the places by walking around and looking at them from different perspectives (Liben & Myers, 2007). Referring to these assumptions and results, it is expected that understanding of the story and adoption of the perspectives of the characters portrayed is enhanced when the text refers to visible, perceptible and accessible objects and places in the sense of backdrops of the story. Moreover, to develop a holistic idea of a story in a specific setting in the sense of a situation model, beneficial effects are also expected from illustrations. This expectation is based on previous findings about the positive effects of illustrations on text comprehension (Mayer, 2021), even though they have been mainly studied for informational text and not for literary texts.

With reference to current assumptions and results on the emotional-motivational development of primary school-aged children, it is assumed that viewing the settings of a story also increases children's involvement during text comprehension. Involvement refers to the phenomenon of losing oneself in a story or connecting with the characters portrayed in a story and is considered to be an important prerequisite for intrinsic reading motivation (Schiefele et al., 2012). In turn, reading motivation as a person's willingness to read is often closely linked to reading behavior and reading ability (Toste et al., 2020), which is particularly true for intrinsic reading motivation, which is driven by the pleasure gained from reading (Heyne et al., 2023). In addition, a strong relationship between involvement and transportation is expected. Transportation refers to the immersion of persons in stories with their attention, vivid mental imaginations as well as with their feelings (Appel et al., 2015; Green & Appel, 2024; Green & Brock, 2000). With reference to the distinction between cognitive and affective components of empathy (e.g., Davis, 1994) – cognitive components of empathy refer to the understanding of the feelings of others (here referred to as *affective perspective taking*), the affective components of empathy refer to the co-experiencing of the feelings of others – transportation can be seen as an affective component of empathy in text comprehension. In contrast, the empathic text comprehension during reading studied by Bertschi-Kaufmann and Schneider (2006) can be classified as a cognitive component of empathy. Their results showed that children are capable of empathic reading comprehension from Grade 3 onwards. Accordingly, children from the third Grade onwards were able to understand and name the feelings of the characters portrayed, which is assumed to be an important prerequisite for the development of reading enjoyment and reading motivation (Heyne & Hermann, 2024). In summary, it is expected that listening to stories and seeing their settings through illustrations or authentic locations promotes students' involvement, transportation, affective perspective taking as well as empathic text comprehension. Moreover, it is assumed that these characteristics can improve students' motivation to engage with the corresponding text, i.e., their intrinsic reading and listening motivation.

From the standpoint of research on instruction and media for teaching speaking, listening and reading skills, it is important to consider students' different prerequisites, and in consequence, to provide adaptive methods, information and feedback (KMK, 2022). In order to promote text comprehension, in particular, individual differences in basic language skills are to take into account, e.g., (academic) vocabulary usually strongly related to the students' language and social backgrounds. Accordingly, classroom research recommends clarifying unknown words when reading and teaching vocabulary in order to promote text comprehension and reading literacy (e.g., Foorman & Wanzek, 2016; Heyne, 2014; Wilson et al., 2012). Outside the classroom, a dictionary function in electronic children's books has proven beneficial for teaching vocabulary (e.g.,

Smeets & Bus, 2014). Even though access to such books for children with a foreign language background is still a topic of discussion (Pfost et al., 2018), these children in particular have great potential to benefit from reading such electronic storybooks (Verhallen et al., 2006). Moreover, previous results indicated that students, including those who are often unmotivated to read, often express high levels of motivation when engaged with electronic storybooks (Ciampa, 2012). Therefore, it is expected that an app that provides options for listening and reading a story with explanations of unknown words can be effective in promoting students' vocabulary and motivation, and thus, skills in listening and reading comprehension. Furthermore, studies in reading research and reading literacy assessment assume processes of text comprehension at different levels that need to be considered and promoted in reading instruction (e.g., Kintsch, 1998; Lenhard, 2019; McElvany et al., 2023; Mullis et al., 2023). For example, these encompass an understanding of facts, inferring and critical reflecting respectively as well as the elaboration of learned content in relation to one's own experiences, knowledge and environments. In reading classrooms, these skills are practiced on the one hand through various questions about the text read in post-reading communication (e.g., Foorman & Wanzek, 2016; Heyne, 2014) and discussions (Wilkinson & Nelson, 2012). In addition, cognitive activation (Hattie, 2009; Schilcher et al., 2023) is ascribed a high importance for learning success, but also for reading promotion (Heyne, 2014). For example, it can be implemented by asking challenging questions that go beyond the content presented and require students to think and reflect for themselves. Accordingly, the app contains questions with various requirements that can be answered by the students and encourage the children and accompanying persons to exchange ideas about the text. In particular, it encompasses questions that require children to recognize facts from the text, to draw conclusions or to reflect on the text content critically as well as in relation to their own experiences and the real-world environment. Moreover, with respect to recommendations in German curricula (KMK, 2022) for the increased use of digital media in lessons, the app also provides a digital offer for listening and reading a story and for encouraging exchange with others.

Finally, the conception and the development of the app has links to the aims of geographical education at primary school age. Central educational objectives in geography lessons at the primary school level are for students to get to know their immediate environment, e.g., to learn about the physical and human features in the school's surroundings and the wider context, and to reflect on their own experiences in this environment (e.g., Rawling, 2022). Narrative geography and narrative spaces are discussed as promising concepts for achieving these objectives in geography lessons (Hofmann, 2014). Accordingly, narratives are characterized by spatial dimensions and by the meaning they give to spaces. Therefore, narratives can support the understanding of different aspects of spaces. With reference to the underlying concept of Soja (1996), three aspects of geographical spaces are distinguished (Hofmann, 2014, 74): a) the *conceived space* describes objective features of the space that can be measured and observed, and which are often documented on maps; b) the *perceived space* refers to features perceived by people, which can be read or heard in diverse media; and c) the *lived space* (*thirdspace*) describes individual experiences that people have in the respective physical surrounding. In line with these approaches, the story in the LitSpatz app addresses various geographical and cultural themes of the region. Thus, it encourages app users to engage with these regional characteristics. In particular, the plot of the story presented in the app can be assigned as a lived perspective of a fictional character at the location. Through the authentic sites addressed within the story, the app also informs users about a number of local geographical features, and thus, the conceived space of the location. For instance, it draws attention to the presence of the two rivers the Regnitz and the Ludwigskanal which flow at different rates of speed and are situated in close proximity to each other in the central area of Bamberg, subsequently converging to form a single body of water. At the end of the story in particular, the protagonist rediscovers his previously stolen treasure, which was transported downstream on the slower flowing Ludwigskanal, by drifting down the faster flowing Regnitz himself. Concerning the perceived space, in the story the idiom *davon schwimmende Felle* (Englisch: floating away skins) – which is a figure of speech for the disappointment of one's own hopes – is used by one figure of the story when passing along the small river (Ludwigskanal). Tanners used to live and work right next to this river. Their work is seen as the origin of the idiom. It refers to the fact that when the tanners were working, it sometimes happened that the almost finished skins were carried away by the water when they were rinsed in the river, and thus, rendering the previous work in vain.

In sum, against the theoretical background outlined above, the LitSpatz app was developed for children of primary school age, in which the aforementioned aspects are applied. In particular, the app offers a digital tool that allows to listen to a walk-in story, read passages and view the locations, and thus, spatial constellations, which is made possible by illustrations or by visiting the authentic locations. The story *Audwin und die Hatz nach dem Schatz* (Englisch: Audwin and the hunt for the treasure), written by Nora Heyne and Bianca Kreuzer in 2022, takes place in various accessible or visible public places in the city of Bamberg. It contains various requirements of text comprehension, in particular, the adoption of affective and spatial perspectives of the various literary characters, the understanding of facts, the derivation of conclusions as well as critical reflection in relation to one's own prior knowledge (including idioms) and one's own living environment. On the one hand, the app can be used to practice mastering these requirements. One the other hand, the students' answers are recorded in the app, in particular, their understanding of facts and critical reflection of the story, their transportation, affective and spatial perspective taking, their empathic text comprehension as well as their habitual reading and situational listening motivation. In addition, the app contains explanations of unknown words to support pupils who do not know these words. Moreover, it encompasses cognitively activating and further questions, e.g., to stimulate critical reflection on the story in relation to the visible environment and to adopt the affective and spatial perspectives of the depicted characters. The story and the associated questions also offer opportunities for exchange with other persons in curricular or extracurricular activities. For these persons, no previous pedagogical knowledge on reading promotion is required to stimulate beneficial follow-up communication about the text presented. In order to investigate the students' characteristics and skills related to text comprehension when using the app, further question are asked at the beginning and at the end of the app, e.g., on students' background (language at home, gender, age, Grade) as well as on their enjoyment of the story.

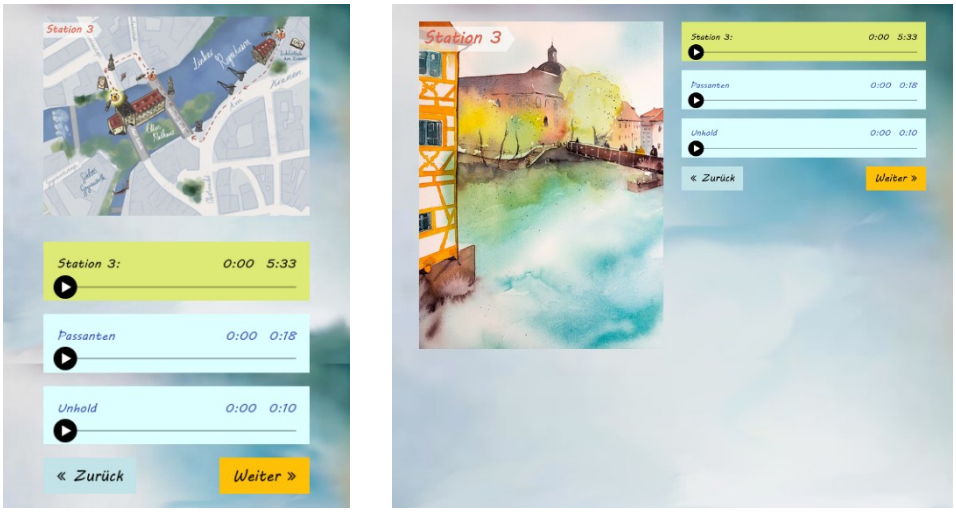
3. Materials and Methods

The LitSpatz app is structured so that users can continuously click through the story. It is presented in six scenes at a total of six locations (for more information on the app, the story or test runs see https://www.uni-bamberg.de/bildungsforschung/litspatz/; for full presentation of all illustrations see Heyne & Hermann, 2024). The following screens appear in a consecutive order for each scene: (a) a site map of the place of the respective scene with instructions on how to get there (see Figure 1 with the exemplary display for station 3), (b) bars to play the audio files of the main story and word explanations, accompanied by an illustration (off-site condition) or a map of the authentic scene (on-site condition) (see Figure 2 with the exemplary next display for station 3), and (c) cognitively activating and further questions, few with adaptive answers, e.g., about

facts or critical text reflections, affective or spatial perspective taking, accompanied by an illustration or a map of the authentic scene (see Figure 3 with the exemplary display for station 4). Questions about students' listening motivation and enjoyment of the story as well as the conditions of their use of the app are presented at the end of the app. Questions about students' background and reading motivation are presented before the start of the story. Furthermore, before starting, a question is asked regarding the version of participation with the options (a) on-site in Bamberg, or (b) off-site from another location. According to the user's choice of participation, only the screens for the selected version are shown in the following. While the total duration of all texts in the (virtual) walk is about 42 minutes, approximately 90 to 120 minutes should be planned for participation, including answering all questions and exchange communication with accompanying persons.

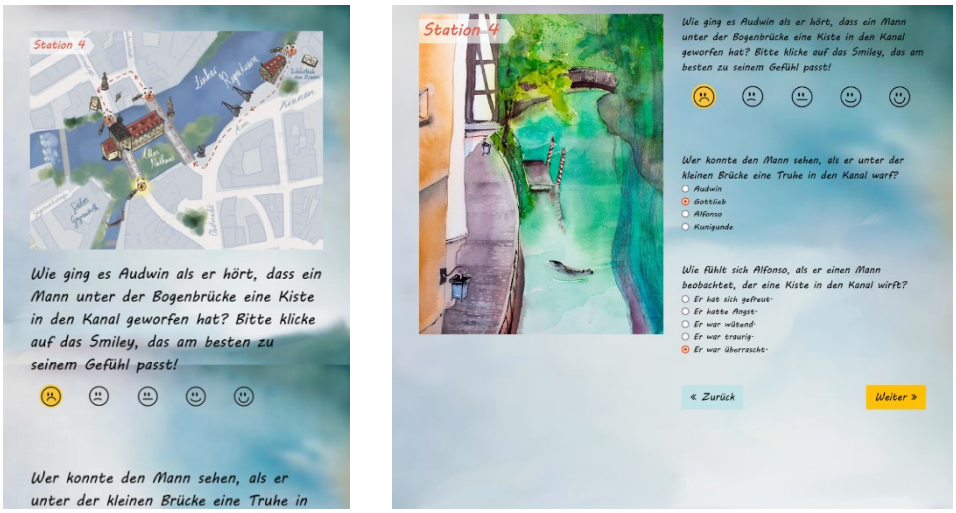
(a) (b)

Figure 1. Screen with a site map of the place of the scene with instructions how to get there (translation of the shown text: To see what happens next, go to station ③ on the map, to the Upper Bridge, and click on *WEITER*!) with similar display contents for a. on-site version via mobile phone and b. off-site version via PC (Buttons at the bottom of the display allow to go back [button *Zurück*] or continue in the app [button *Weiter*]).



(a) (b)

Figure 2. Screen with bars for playing the audio file of the story at station 3 and word explanations (here for *Passanten* [passers-by] and *Unhold* [Fiend] which are mentioned in the scene), accompanied by a map of the authentic place (a. on-site version via mobile phone) or an illustration (b. off-site version via PC); Buttons at the bottom of the display allow to go back (*Zurück*) or continue in the app (*Weiter*).



(a) (b)

Figure 3. Screen with questions with demands of affective or spatial perspective taking, accompanied by a site map of the authentic place (a. on-site version via mobile phone) or an illustration (b. off-site version via PC); Displayed questions are: 1) How did Audwin feel when he heard that a man had thrown a crate into the canal under the arched bridge? (to be answered by clicking on the best matching smiley according to the participant's assessment), 2) Who could see the man as he threw a crate into the canal under the small bridge? (to be answered by clicking on the corresponding name of the character [*Audwin*, *Gottlieb*, *Alfonso* or *Kunigunde*]), 3) How does Alfonso feel when he sees a man throwing a crate into the canal? (to be answered by clicking on the appropriate answer option [*He was happy.*, *He was scared.*, *He was angry.*, *He was sad.* or *He was surprised.*]); Buttons at the bottom of the display allow to go back (*Zurück*) or continue in the app (*Weiter*).

In order to evaluate the use of the app and the relationships between the characteristics and skills of the students in relation to text comprehension, the following variables were collected, mostly using multiple-choice questions, after the different scences (see Table 1): Reading motivation (RMO; see exemplary item in Table A1 in appendix) was assessed by using an existing scale consisting of six items with 4-level response options (*not at all true* to *very true*) by Wendt and colleagues (2016). Transportation (TP) was measured using a scale with four items that was adapted for children in the course of a previous study (Heyne & Hermann, 2024; see exemplary item in Table A2 in appendix) with reference to the scale designed for adults by Appel and colleagues (2015). Furthermore, to assess students' empathic text comprehension while listening (ETL) which is defined as the ability to perceive the emotional state of the characters in the presented story and its changes we used a previously developed scale by Heyne and Hermann (2024). Thereby the valences of the emotional states of a particular character in a given scene were to be assessed using a five-point Kunin scale (see exemplary item in Figure A1 in appendix). Listening motivation (LMO) was assessed by a scale that was adapted within the project referring to the situational interest scale by Schraw and colleagues (1995; see exemplary item in Table A3 in appendix). For the assessment of further characteristics, skills and prerequisites of students, scales and items were used that were developed in earlier studies. Accordingly, questions with four answering options were presented to assess students' abilities in text comprehension (TC), particularly, in understanding facts in the text (three questions; see exemplary item in Table A4 in appendix) and drawing conclusions and critical text reflection on the text content (two questions; see item in Table A5 in appendix). Similarly, five structured questions were used to capture the spatial perspective taking, which refers to the understanding of the spatial perspectives of certain literary characters (see exemplary item in Table A6 in appendix). To assess affective perspective-taking, five items with five response options were used, each representing different feelings of the respective character in a described situation (see exemplary item in Table A7 in appendix). Scores for correct responses were summed to reflect the respondent's ability on each of these three scales. The enjoyment of the story (EOS) was captured by a single item presented as Kunin-Scale (see Figure A2 in appendix). Finally, gender (answering options: *boy*, *girl*, *diverse*) and the language spoken at home (answering options: *German*, *other language*, *both*) were captured by means of multiple-choice questions, while questions about age and Grade were open-ended and had to be filled in by the students.

The LitSpatz app runs on a server at the University of Bamberg. It is browser-based and can be used on standard devices with internet access (Android, iOS) and is free of charge after registration by the students' parents through the registration portal (access codes for a login are time limited). Based on django and mysql, the application itself is programmed in Python. The pages are ordered in a linear sequence of the story and include the maps and illustrations, audio files, written text and questions mentioned above. When developing the graphical user interface, it was the central goal to keep it simple, comprehensible and accessible for primary students. As the users progress through the stations, log-data can be recorded and used for later scientific comparative analyses, for example, to compare usage of the on-site and the off-site version. The development of the app was accompanied by the data protection officer of the University of Bamberg and the collection, storage and processing of data is carried out in accordance with the institution's regulations, which are based on the General Data Protection Regulation. Informed parental consent is mandatory for the use of the app. In the current version of the app, all survey questions on students' text comprehension, relevant background characteristics, etc. were integrated in the app. This means that the survey, data collection and reading intervention practically go hand in hand.

Table 1. Overview of scenes of the walkable story[1] with information presented and characteristics and skills recorded in the off-site version

Phase	Main topics/ Plot	Location	Presented information	Recorded information[2]
1 Introduction	Welcome, introduction of the procedure, initial questions	City of Bamberg	• Illustration of the cover • Text (greeting, title of the story)	• Type of participation (off-site versus on-site) • Demographics (age, gender, Grade, language at home) • Reading motivation (Scale)
2 Scene 1	*Emil*, a schoolboy reading and daydreaming[3], accidentally meets *Audwin*[4] who has a box with him and begins to talk about his past experiences.	Station 1	• Map and directions to station 1 • Illustration of location 1 • Audiofile of scene 1 • Audiofiles for unknown words (3)	• Question whether described objects are seen (with feedback; 1 item) • Finding facts (2 items)
3 Scene 2	A. tells how he heard loud noises from the beached bridge and several people (e.g., *Kunigunde*[5] and others with controversial statements) and set off with his raft to find out what had happened.	Station 2	• Map and directions to station 2 • Illustration of location 2 • Audiofile of scene 2 • Audiofiles for unknown words (5)	• Question whether described objects are seen (with feedback; 1 item) • Finding facts (1 item) and text reflection (1 item)
4 Scene 3	A. recounts what the neighbor *Gottlieb*[5] tells him about the riot (misunderstandings, persecution of innocent people) and how it came about (a stranger came by with a box). A. believes that the box mentioned must have been his own and sets off in search of it.	Station 3	• Map and directions to station 3 • Illustration of location 3 • Audiofile of scene 3 • Audiofiles for unknown words (2)	• Empathic text comprehension (3 items) • Spatial perspective taking (3 items) • Affective perspective taking (2 items)
5 Scene 4	A. tells of his crossing to the island between the Regnitz and Ludwigskanal and his encounter with the gondolier *Alfonso*[5] who tells him about his observations (stranger sinks crate in the Ludwigskanal; crate reappears and floats downstream).	Station 4	• Map and directions to station 4 • Illustration of location 4 • Audiofile of scene 4 • Audiofiles for unknown words (2)	• Empathic text comprehension (1 item) • Spatial perspective taking (1 item) • Affective perspective taking (1 item)
6 Scene 5	A. tells of his idea to float down the faster river and how he managed to catch up with his treasure and then met the gondolier again.	Station 5	• Map and directions to station 5 • Illustration of location 5 • Audiofile of scene 5	• Empathic text comprehension (1 item) • Affective perspective taking (1 item) • Text reflection (1 item)
7 Scene 6	A. tells how he swims under the building on stilts next to the library and inspects his chest, where he is discovered by *Emil.*	Station 6	• Map and directions to station 6 • Illustration of location 6 • Audiofile of scene 6	
8 Conclusion	Ending of the story, final questions, feedback, thanks and farewell	Station 6	• Illustration of location 6 • Text (title of the story, farewell)	• Enjoyment of the story (1 item) • Transportation (Scale) • Listening motivation (Scale)

Note. [1]The term *walkable story* is used with reference to formats known from cultural contributions, which are characterized by the fact that content is presented in authentic, physical, symbolic or otherwise represented environments and can be experienced with different senses. Accordingly, the app users can follow the protagonist's path in the story presented and get a holistic picture of the locations, e.g., see the spatial arrangement of the paths and rivers, which, as expected, supports their understanding of the text and their adoption of perspectives. [2]Data collection was based on items with or without answer options. [3]The plot is embedded in a framework story that is not described in detail here. [4]Main character. [5]Secondary character.

The study presented is based on data of a sample of 3rd Grade students (N = 52) who used the app for virtual literary walks with illustrations on Tablet PCs in two consecutive school lessons in their classrooms. The results of this pilot study are presented in the following. Nevertheless, data collection from participants in the on-site version of literary walks is still running due to the low participation rate of this version in the private and non-formal contexts so far.

4. Results

During the implementation of the pilot run, it was observed that after a brief verbal introduction to the app, students used the app largely independently and without questions or interruptions. Descriptive statistics and correlations of students' characteristics and skills related to text comprehension when using the app are shown in Table 2. The mean scores for affective (AP) and spatial perspective taking (SP) both indicators of

students' capacity to transfer to and understand the emotional and spatial situations of certain literary characters are approximately in the middle of the scale range of the respective scales. Furthermore, moderate standard deviations of these two variables are observed, indicating medium differences between the individual responses of the students. Moreover, students gained a relatively high mean score in empathic text comprehension in listening (ETL), again with a fairly moderate standard deviation. This indicates that many of the students were able to perceive the emotional states of the main character of the story and their changes. Similarly, the means of reading motivation (RMO) and transportation (TP) exceed the theoretical scale mean. Thus, on average, the participating children reported a high level of general enjoyment of reading and often let themselves be transported into the fictional world of a book or lose themselves in it while reading. In addition, the mean values of listening motivation (LMO) and enjoyment of the story (EOS) show very high values that are close to the respective maxima of the scales and low standard deviations. Therefore, in addition to a high general motivation to read, they were also highly motivated to listen to the story currently presented in the Litspatz app, and they liked the story very much. Moreover, the students' text comprehension is on average slightly above the mean value of the scale, with none of the students achieving the full score. Finally, the table shows the correlations between the characteristics and skills surveyed, which indicate several significant positive correlations. Affective (AP) and spatial (SP) perspective taking were positively related to empathic text comprehension (ETL). General reading motivation (RMO) was positively correlated with transportation (TP), along with story specific measures of listening motivation (LMO) and enjoyment of the LitSpatz app (EOS). Text comprehension (TC) was positively associated with affective perspective taking (AP) and empathic text comprehension (ETL). Interestingly, reading motivation (RMO) was negatively associated with empathic text comprehension (ETL). Furthermore, transportation (TP) correlated strongly with listening motivation (LMO) and, to a lesser extent, with enjoyment of the LitSpatz story (EOS). Finally, high enjoyment of the LitSpatz story (EOS) showed a strong positive association with motivation to listen to the story (LMO).

Table 2. Descriptive results of characteristics and skills of students using the off-site version of the app LitSpatz in classrooms

							Correlations						
	Variable	Range	*M*	*SD*	*Min*	*Max*	1	2	3	4	5	6	7
1	AP	0.00–4.00	2.13	0.99	0.00	4.00							
2	SP	0.00–4.00	2.12	1.06	0.00	4.00	.15[a]						
3	RMO	1.00–4.00	3.08	0.79	1.00	4.00	-.06[a]	-.05[a]					
4	TP	1.00–4.00	3.23	0.75	1.00	4.00	-.11[a]	.05[a]	.44***[b]				
5	ETL	0.00–1.00	0.79	0.24	0.33	1.00	.31**[b]	.31**[b]	-.24***[b]	-.08[b]			
6	LMO	1.00–4.00	3.64	0.45	2.00	4.00	-.02[a]	.06[a]	.56***[b]	.58**[b]	-.05[b]		
7	EOS	1.00–5.00	4.79	0.50	3.00	5.00	.10[a]	.07[a]	.49***[a]	.37***[a]	-.09[b]	.54***[a]	
8	TC	0.00–5.00	2.83	1.10	0.00	4.00	.25*[a]	.06[a]	-.03[a]	-.06[a]	.31*[a]	.21[a]	.10[a]

Note. AP = affective perspective taking (sum score); SP = spatial perspective taking (sum score); RMO = reading motivation (mean score; Cronbach's α = .81), TP = transportation (mean score 1; Cronbach's α = .77); ETL = empathic text comprehension (mean score; Cronbach's α = .69); LMO = listening motivation (mean score; Cronbach's α = .74); EOS = enjoyment of the story; TC = text comprehension (sum score); Range = theoretical scale range; *M* = mean; *SD* = standard deviation; *Min* = minimum; *Max* = maximum; no missings; correlationen with Kendal's Tau[a], Pearson[b];
*** $p < .001$, ** $p < .01$, * $p < .05$

5. Discussion

The results of the pilot study with the off-site version in classrooms pointed to good functionality of the app and high user acceptance. This is well expressed by the students, indicating high levels of motivation to listen and the enjoyment of the story. These results are consistent with initial research showing that students often express high levels of motivation when engaged with electronic storybooks (Ciampa, 2012). Furthermore, on average, the participating children showed good affective and spatial perspective taking while listening to the story, although a moderate level of variance was also observed. Interestingly, students' affective and spatial perspective taking was not related to students' listening motivation and enjoyment of the story. Therefore, enjoyment of a particular story seems not necessarily tied to a full understanding of the affective and spatial perspectives of the characters in the story. Although this assumption needs further empirical research, it is possible that story enjoyment may be due to different sources within the story, and therefore a correct understanding of the spatial and affective perspective of the story characters is not a necessity for story enjoyment for all children.

However, enjoyment of the story and listening motivation was positively related to children's reading motivation and transportation. This finding underlined previous expectations of positive relations between these characteristics of the students. In particular, these positive correlations consolidated the assumptions on beneficial effects of transportation for reading motivation (Lenhard, 2019; Heyne & Hermann, 2024). Furthermore, reading motivation is positively related to reading ability (Toste et al., 2020), and children with better reading ability may in turn be more prone to experiencing flow while reading, which ultimately increases the likelihood of transportation (Green & Appel, 2024). Interestingly, within this study, transportation was not related to empathic text comprehension. In addition, reading motivation even was negatively associated with empathic text comprehension, which is inconsistent with the expectations. Whether this negative relationship is confirmed in a larger sample, or whether it is perhaps moderated by the level of reading literacy, requires further investigation.

As reported above, the use of the on-site version of the app in private and non-formal contexts so far was comparatively low. As a result, there is not yet sufficient data to compare the two versions of the app (on-site and off-site) in terms of students' characteristics and text comprehension skills. However, the experiences with the functionality of the app as well as the results of students' acceptance of the app in terms of their listening motivation and enjoyment of the story when using the app in the classroom suggest that aspects of functionality and acceptance can be excluded as reasons for low participation in private and non-formal contexts. Therefore, reasons for the low participation in the on-site version in private and non-formal contexts are unknown and could be diverse: For example, parents often report a lack of time to take part due to work and other obligations. As the literary walks are advertised as lasting between 90 and 120 minutes, this may be difficult for many families to arrange. Another possibility is that parents have difficulties filling out the form of informed consent and data protection in the registration procedure, especially parents with a foreign language background. The large number of technical terms used in these forms may have a deterrent effect and reduce the willingness to participate accordingly. In addition to these demanding technical requirements for using the app, the infrequent feedback on the children's answers and the less explicit prompts for open discussion about text comprehension can also be seen as critical challenges of the app that need to be addressed in future implementations.

6. Conclusions

From a research perspective, further investigation of the app and its effects is needed. This includes a participation of a larger sample of students and the implementation of both versions of the app (a. on-site versus b. off-site) in two groups of students for comparison. In addition, an implementation of a longitudinal study design with a pre- and a post-test promises to gain more differentiated insights on effects. In particular, it promises insights of whether children with regular use of corresponding apps show increases in the promoted skills of text comprehension, e.g., vocabulary, findings facts, critical text reflection or in their knowledge about the geographical features of the context, compared to children without the use of a corresponding app. Moreover, further implementation of geospatial data and technologies – for example by providing GIS-tailored prompts based on user's geographical position (Herselman et al., 2010) – should be explored to identify further app features that can potentially challenge, motivate and promote students' characteristics and skills.

From a practical point of view, the high level of student acceptance suggests that apps such as LitSpatz could provide user-accepted tools to promote students' motivation and skills related to text comprehension. However, in order to further develop and improve such applications, it is necessary to identify their beneficial features. Moreover, in the further development and evaluation of these applications, special consideration should be given to a heterogeneous reading population in terms of differences relating to gender, language of origin or family educational background, for example. Finally, if the use of the app shows beneficial effects on the students' skills and characteristics, its potential can be used for other application situations. For example, the story could be made available web-based and in different languages for children in various places in Europe and beyond, thus contributing to the implementation of the objectives of the Common European Framework of Reference for Languages (Council of Europe, 2020).

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Appendix A

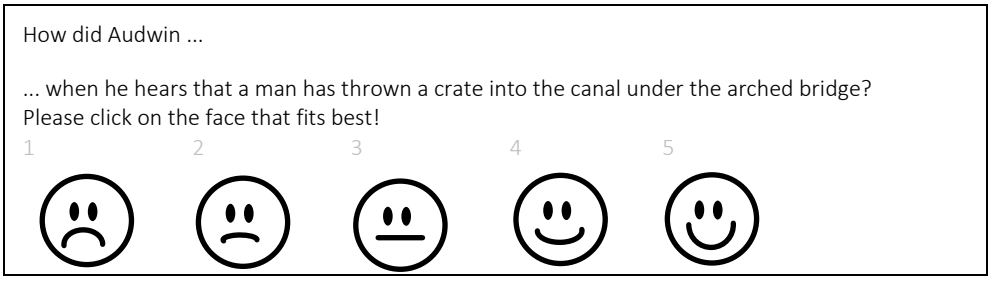

Figure A1: Example item for recording the empathic text comprehension while listening (ETL) based on a Kunin-scale with 5 response options (Coding: 1 = *very bad*, 2 = *bad*, 3 = *average*, 4 = *good*, 5 = *very good*; translated item version of Heyne & Herrmann, 2024)

How did you like the story?

Please click on the face that fits best!

1 2 3 4 5

Figure A2: Item for recording the enjoyment of the story based on a Kunin-Scale with 5 response options (Coding: 1 = *very bad*, 2 = *bad*, 3 = *average*, 4 = *good*, 5 = *very good*; translated item version of Heyne & Herrmann, 2024)

Table A1: Example item for recording the reading motivation (translated version from a scale developed by Wendt et al., 2016, 63)

To what extent do the following statements apply to you? Please check one box in each line!	not at all true	rather not true	rather true	very true
I like to read.	☐	☐	☐	☐

Table A2: Example item for recording the transportation (translated item version of Heyne & Hermann, 2024, adapted from a scale for adults by Appel et al., 2015)

To what extent do the following statements apply to you? Please check one box in each line!	not at all true	rather not true	rather true	very true
As I listened to the story, I could imagine Audwin vividly.	☐	☐	☐	☐

Table A3: Example item for recording the listening motivation (translated version from a scale developed by Schraw et al., 1995, 15)

To what extent do the following statements apply to you? Please check one box in each line!	not at all true	rather not true	rather true	very true
I enjoyed listening to it.	☐	☐	☐	☐

Table A4: Example item for recording understanding of facts (translated item version of Heyne & Herrmann, 2024)

Why do you think Emil called his little book 'Wonder Words'?

Because in it he...

1 ☐ ... collected spells that he wanted to use.
2 ☐ ... noted down things he wanted to find out.
3 ☐ ... collected recipes that he wanted to try out.
4 ☐ ... noted down things he wanted to build.

Table A5: Item for recording drawing conclusions and critical text reflection on text content (translated item version of Heyne & Herrmann, 2024)

When Audwin set off in the morning, he wanted to find out what had happened. He had a hunch and heard what various people were saying. Now you know what happened - which of the people was right?

1 ☐ Neighbors who shouted that thieves were stealing crates.
2 ☐ A man who thought that pigeons were nesting in the gable.
3 ☐ Guys who thought gardeners robbed crates.
4 ☐ A gentleman who said that a man was carrying away a crate.

Table A6: Example item for recording spatial perspective taking (translated item version of Heyne & Herrmann, 2024)

Who could see **the man** throwing a crate into the canal under the small bridge?

Please tick **only one box.**

1 ☐	Audwin
2 ☐	Gottlieb
3 ☐	Alfonso
4 ☐	Kunigunde

Table A7: Example item for recording affective perspective taking (translated item version of Heyne & Herrmann, 2024)

How does Audwin feel when he grabs his treasure in the river and floats with it in the water? Please tick **only one box**.
1 ☐ He was happy.
2 ☐ He was scared.
3 ☐ He was angry.
4 ☐ He was sad.
5 ☐ He was surprised.

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