Chen, X., & Zhang, Y. (2023). Virtual field trips in K-12 classroom teaching: A systematic review. *International Journal of Technology in Teaching and Learning, 19*(*1*), 52-68.

Virtual Field Trips in K-12 Classroom Teaching: A Systematic Review

Xiaojun Chen
St. John's University
Ying Zhang
Robert Morris University

This systematic review examines the pedagogical gap of how VFTs are adopted and integrated in K-12 classroom teaching and learning. Specifically, it focuses on the grade levels and subject areas, learning outcomes and pedagogical activities involved VFTs at elementary and secondary levels. The results of this review show the current usage of VFTs occurs more often in science and history-related classes for secondary students, mainly due to VFTs' affordances in offering access to unreachable exploration, visualization of complex concepts, and time change observation. It also reveals that the implementation of VFTs can lead to positive cognitive and affective learning gains when a variety of carefully designed pedagogical activities are used, among which scaffolding and procedural strategies are highlighted. The results also demonstrated that high levels of peer-to-peer interaction coincide with high levels of teacher-to-student interaction, however, high teacher-to-student interaction may not necessarily lead to high peer-to-peer interaction, indicating that need to design specific activities to promote student interaction among themselves. Thus, future research and practice may explore how VFTs can be used to enhance higher order thinking skills, such as analysis and synthesis, and teachers are to be empowered in the processes of VFT creation and adoption.

Key Words: virtual field trips, systematic review, K-12 classrooms

INTRODUCTION

Virtual field trips (VFTs) have been adopted in K-12 education in recent years, offering a variety of benefits that address the diverse needs of students from various socioeconomic, linguistic, and cultural backgrounds. Virtual field trip is often defined as digital environments that facilitate exploration of distant sites without physical presence (Hosticka, Schriver, Bedell, & Clark, 2002; Procter, 2012). In terms of societal value, VFTs

Dr. Xiaojun Chen is Associate Professor in the Department of Curriculum and Instruction, School of Education, St. John's University, and can be reached at chenx@stjohns.edu. Dr. Ying Zhang is Associate Professor in the Department of Education in School of Nursing, Education and Human Studies, Robert Morris University, and can be reached at zhang@rmu.edu.
DOI: https://doi.org/10.37120/ijttl.2023.19.1.03

represent a leap forward in providing equal access to experiential and authentic learning experiences. Their widespread adoption, particularly during the COVID-19 pandemic's remote teaching phase, has been well-received, as evidenced by the positive perceptions of both teachers and students (Norris et al., 2015; Han, 2021; Bhargaw, 2021).

Research across content areas such as science (Harron et al., 2019; Petersen et al., 2020), social studies (Kenna & Potter, 2018), and literacy education (Blachowicz & Obrochta, 2005; Delacruz, 2019) underscores the versatility and instructional utility of VFTs. Researchers have reported that VFTs can enhance student engagement as motivational tools (Cheng & Tsai, 2019; Zhao et al., 2022), as well as facilitate new interactions between teachers and students (Cheng & Tsai, 2019). VFTs have also been linked to increased declarative knowledge and self-efficacy among learners (Petersen et al., 2020), as well as improved content mastery (Mead et al., 2019). Furthermore, VFTs have been acknowledged for fostering an inclusive classroom environment (Kenna & Potter, 2018).

These scholarly advancement shows the potential of VFTs engaging and supporting student learning, However, the literature also highlights some limitations of VFTs, such as constrained social interaction and challenges in knowledge construction when compared to traditional field trips (Han, 2020). Given the growing prominence of VFTs in educational settings, a systematic review of their impact is essential to chart the course for future scholarly inquiry and pedagogical strategies. Such a review will be invaluable in capitalizing on the strengths of VFTs while addressing their limitations to enhance the quality of learning experiences for K-12 students.

VIRTUAL FIELD TRIPS AND SITUATED LEARNING

Virtual Field Trips (VFTs) engage learners in immersive digital environments, allowing them to virtually explore remote locations they might not be able to visit in person. This method of learning aligns closely with the concept of situated learning, as posited by Lave and Wenger (1991), where the context of learning is crucial in framing and enriching learners' experiences. Procter (2012) in their analysis of field trips underscores this connection, stating that “the virtual field trip combines situated, problem-based learning” (p.980). Situated learning is fundamentally about the relevance and impact of context in learning. It posits that learning is most effective when it is directly tied to the context in which it will be applied. VFTs, by creating a virtual context, allow students to engage with the material in a setting that closely mirrors real-life applications. This context-centric approach is vital in ensuring that the learning experiences are meaningful and resonate with the learners.

However, the efficacy of VFTs is not solely dependent on the technology or the virtual environment itself. The role of educators in this process is pivotal. Allowing educators and teachers to not only in navigating the technical aspects of the technological learning aspect, but also effectively integrate to the current curriculum. This integration requires a deep understanding of the content knowledge, clear learning goals and objectives, and an awareness of students’ background knowledge in both the disciplinary content and technological familiarity (Etmer, Ottenbreit-Leftwich, Sadik, Sendurur & Sendurur, 2012; Herring, Koehler & Mishra, 2016; Mishra, 2019). Researchers have been advocating and emphasizing the significance of teachers' roles in successfully implementing technology in education, particularly in terms of aligning virtual experiences with educational objectives and considering students' diverse needs and abilities (Backfisch, Lachner, Stürmer & Scheiter, 2021; Hamilton, Rosenberg & Akcaoglu, 2016; Hew and Brush, 2007).

PRIOR REVIEWS LIMITATION AND REVIEW PURPOSE OF CURRENT STUDY

Prior to commencing this systematic review, the researchers identified related studies with varying scopes. For instance, Ennes and Lee (2021) conducted a review of published literature that centered on distance learning programs, specifically those offered by museums. In a separate study, Merritt and her colleagues (Merritt et al., 2022) examined program characteristics in digital environmental education experiences and proposed 12 guiding principles aimed at enhancing environmental literacy for K-12 students. These principles include social-ecological connections, relevance, social interactions, role models, autonomy, active involvement, challenge, use of multiple modalities, positive framing, preparation, feedback and reflection. Another review authored by Aleshia and her team (2021) focused on the integration of Virtual Reality (VR) into lesson plans for teachers in K-16 education.

While these previous literature reviews offer valuable insights into the broader use of immersive technology and emerging educational tools for K-12 classrooms, no specific literature review has been conducted to explore the utilization of Virtual Field Trips (VFTs) for educational purposes, particularly within the context of K-12 classrooms. Consequently, there exists an opportunity to address this gap through a systematic review that delves into how VFTs are planned, adopted, and utilized in K-12 educational settings, with a particular emphasis on grade level and subjects, learning outcomes and pedagogical practices of virtual field trips.

GRADE LEVEL AND SUBJECTS. Surveying through the literature, a particular focus has been taken to examine the grade levels and subjects of VFTs' integration. Understanding the grade levels and subjects for which VFTs are integrated into teaching is pivotal for multiple reasons. First, it helps to understand how VFTs are compatible with the students' cognitive and maturity levels. Second, for subject-specific applications, the knowledge of how VFTs are used can inform the potential compatibility between the VFTs and the nature of different disciplines and further point out the unique affordances of VFTs. As a result, this information may point out future directions for research and classroom practices. In the future, identifying successful applications of VFTs within certain grades and subjects can lead to a repository of best practices, helping educators to implement VFTs more effectively.

LEARNING OUTCOMES. Another focus is to examine the learning outcomes, and in this review the researchers analyzed the learning outcomes for VFT in the situated learning context from affective, behavioral, and cognitive dimensions (Allen et al., 2013, Bloom, 2006; Pianta et al., 2008). The affective domain concerns how students deal with things emotionally, for example, how students feel, value, and perceive their learning. The behavioral dimension includes physical movement, coordination, and use of the motor skills. The cognitive domain involves knowledge gain and conceptual development. Bloom (2006) identified different categories of cognitive learning, from simple recall to more advanced skills such as analyze and synthesize. These dimensions interact and influence each other, making learning a holistic process. Aligning the needs of the students in each of the learning domain, implementing VFTs in classrooms needs to consider students' perceptions (Woo-Hee, et al., 2001), attitudes (Norris et al., 2015), interests (Petersen et al., 2020), learning formats (Lee et al., 2022; Tutwiler et al., 2013), behavioral change (Hasenbein et al., 2022) and concept development (Lee et al., 2022). Several studies in our literature review have reported student learning in different dimensions. It is essential to

understand how these three dimensions are focused in hope the review can provide insights for future research and practices.

PEDAGOGICAL PRACTICES OF VIRTUAL FIELD TRIP. The third focus is to study the pedagogical practices documented in literature. Pedagogical practices are related to teaching methods and/or strategies used by teachers to facilitate learning and impact knowledge or skills to students. On one hand, teacher and student interactions are examined to understand the nature of classroom communication when VFTs are incorporated into the curriculum. On the other hand, anchoring VFT in situated learning environments, this review would look into strategies to facilitate learning of procedural knowledge when VFTs are purposefully embedded in curriculums, such as introductory teaching. Another focus of the review is to look for pedagogical strategies that are based on social-constructivism (Vygotsky, 1962, 1978) which provide scaffoldings through strategies such as questioning and discussion (Gallimore & Tharp, 1990). By analyzing the teaching practices documented in literature, the researchers hope to broaden the teaching repertoire to enhance teachers to better incorporate VFTs in their disciplines. This may further deepen our insights to help us gain deeper understanding between teaching objectives, VFT affordances, teaching practices, and learning outcomes.

METHODS

RESEARCH QUESTIONS

This study focuses on cumulative research for the past ten years (2012-2022) to address the following research questions:

1. What subjects and grade levels are targeted when using virtual field trips?
2. What learning outcomes result when using virtual field trips in K-12 classrooms?
3. What pedagogical activities/strategies are used or planned involving virtual field trips in various subject areas in K-12 classrooms?

SEARCH PROCEDURE AND INCLUSIONG CRITERIA

The systematic literature review method was used in the study. Following the PRISMA guidelines, researchers included search procedure, inclusion criteria, data source and evidence, code procedure and analysis in this section.

The study examines the articles published in seven (7) major scientific databases from 2012-2022 to investigate the research trends of the topic including: *JSTOR, Science Direct, EBSCO Host, ProQuest Central, Taylor and Francis Journals, Sage Premier, and Wiley*. The initial search inclusion criteria were: 1) peer-reviewed, 2) journal articles, 3) published between 2012-July 2022, and 4) written in English.

DATA SOURCES AND EVIDENCE

Before the first round of data collection, the researchers started with a simple search of the literature and collected the key terms describing the idea of VFTs, hence the following keywords were identified: *virtual/online/immersive/virtual reality field trips*. To narrow down the search to the targeted grade level (i.e. K-12 students), the following keywords were used: *elementary/primary school, middle school, high school, secondary, and K-12*

students. As the research questions target pedagogical activities, and learning outcomes, the following keywords were also identified and used: *pedagogy, teaching and learning.*

After the initial list of keywords had been identified, the researchers retrieved journal articles based on the inclusion criteria in the chosen seven databases. Both researchers co-conducted the initial search to ensure search accuracy. The initial online searches of the aforementioned datasets identified 788 papers, including 416 duplicated records. The researchers then examined the 372 papers by reading the titles and abstracts and excluded 335 papers based on the following criteria: 1) non-education field; 2) non-K-12 targeted; and 3) not VFTs specific. The researchers then conducted the second-round screening by reading the full paper and narrowed the collected literature to include only the research studies with empirical data in K-12 classrooms that focus on classroom activities, pedagogy, and learning outcomes. In the end, 22 papers were coded and included in the final literature synthesis.

CODING PROCEDURE AND ANALYSIS

In the data coding stage, the information in the selected paper (*n*=22) was extracted and evaluated. Two researchers started open coding individually. Each researcher coded half of the papers by focusing on the abstract, research questions, methods, research findings, and the discussion. Researchers then switched and open coded the next half of the papers. During the process, codes were determined based on research questions and theoretical framework. For example, researchers considered the pedagogy, strategies, and learning domains. Each code was then defined with a definition. After the open coding, the researchers compared each other's codes, discussed and came to agreement with each code and its definition. Researchers then conducted the axial coding to further identify the patterns and themes.

RESULTS

The systematic review uncovered 22 papers centered on implementing digital game-based learning in primary education. This section presents an overview of the selected papers (n=22) and then addresses the research question. Analyses were conducted on 22 papers to answer the research question identified above.

RESEARCH QUESTION 1

Table 1 shows the numbers (*n*) of various subjects and grade levels when VFTs were integrated in teaching. It is found that most of the VFTs were used in teaching science (*n* = 10), such as geography, biology, ecology, health science and climate change. Few studies focused on humanities subjects, including history (*n*=5) and English/literacy (*n*=1). Studies were also conducted in multidisciplinary nature which include more than one subject (*n*= 2), and other skills, such as life skills (*n*=2) and virtual attention *(n*=1). These findings are not surprising as VFTs by nature provide opportunities for students to explore inaccessible locations, visualize complex concepts, and experience time lapse, which align nicely with science and history topics.

As shown in Table 2, the majority of the learning involving using VFTs happened at secondary levels (*n* =13), and at elementary level, most of the VFT lessons centered on upper elementary students. This finding shows the affordances of VFTs generally align better with characteristics of adolescent students. The result aligns well with the inherent capabilities of VFTs, such as exploring remote or conceptually complex locations and

phenomena, making them particularly suitable for subjects like geography, biology, and climate change. The lesser focus on subjects like history and English, though present, indicates a potential area for further exploration and application of VFTs. Additionally, the prevalent use of VFTs in secondary education can be attributed to the developmental stage of students at this level. As Piaget's theory suggests (1970), adolescents possess a greater capacity for abstract thinking and are generally more adept at navigating technology, factors that enhance the effectiveness and appeal of VFTs for this age group. This points to a broader educational trend where the alignment of technological tools with cognitive development stages can significantly impact their efficacy and acceptance in learning environments. There remains, however, an opportunity to expand the use of VFTs to younger students and other subject areas, potentially broadening their impact and utility in diverse educational settings.

Table 1. *Subject Areas involving Using VFTs*

Subject	Number of Study
Science (biology, geography)	10
English/Literacy	1
English as Foreign Language	1
History/Social Studies	5
Multi-Subject including STEM	2
Other Subjects (including life skills, safety, etc.)	3
Total	22

Table 2. *Grade Level Involving Using VFTs*

Grade Level	Number of Study
Elementary Level (Grade 1-6)	8
Secondary Level (Grade 7-12)	13
Across Elementary and Secondary Level	1
Total	22

RESEARCH QUESTION 2

Research Question 2 concerns learning outcomes of using VFTs in teaching. The codes reviewed that the majority of the literature focused on cognitive learning, including knowledge acquisition, content recall and retention. Table 3 shows the number of papers that address the various learning outcomes when learning with VFTs. Six (6) articles studied the affective learning outcomes, including student and teacher perceptions, attitudes, interests, and motivation. Six (6) articles focused on cognitive learning outcomes by examining the changes in *knowledge acquisition and knowledge recall*. One (1) article

(Norris et al., 2015) reported on changes in students' motor skills. Nine (9) studies examined learning outcomes from multiple perspectives, including both cognitive and affective aspects. Among the studies, Makransky and Mayer (2022) investigated the learning effectiveness of middle school students after students took a virtual field trip to Greenland via a head mounted display (HMD) or a 2D video. They examined students' learning from several aspects, such as enjoyment, and knowledge retention. The results suggest that *emotional/psychological aspects of learning* are as important to consider as the *intellectual aspect of learning* when implementing VFT in classrooms.

On the other hand, the studies under review have also shown evidence of employing a diverse array of data types to evaluate student learning outcomes. These studies reflected the approach suggested by Chen et al. (2022), advocating for the utilization of varied data sets, enhancing the robustness and comprehensiveness of learning outcome assessments. Such a strategy ensures a more nuanced and holistic understanding of the educational impacts. In Han's (2021) study about elementary students' perceptions of immersive virtual field trips, the researchers incorporated students' reflection papers, along with classroom observations and teacher interviews. Lin and colleagues (2012) used a pre-intervention task, several during-intervention tasks, a pre-post content knowledge test and an affective questionnaire to study the gender's role in using VFTs. This approach may create a more holistic understanding of learning involving multiple facets.

Table 3. *Purpose and Learning Outcomes of VFTs Adopted in Classrooms*

Learning Outcome	Number of Study
Affective Domain (perceptions, attitude and motivation)	6
Cognitive Domain (knowledge acquisition/knowledge recall)	6
Motor Skill Domain (skill outcomes)	1
More than One Domain	9
Total	22

Furthermore, among the reviewed studies, 11 articles reported positive learning outcomes in the affective domain, including *increased attitudes, self-efficacy, interest, perceptions, enjoyment, and engagement*. For example, in Woo-Hee et al.'s (2021) study, the researchers evaluated middle school students' affective learning outcomes after having students viewed a virtual geology field trip of the Baengnyeong Island in South Korea. The statistical analysis showed that this program had a positive impact on student's scientific attitude. Another study in the review conducted by Petersen and colleagues (Petersen et al., 2020) reported a case where middle school students were assigned to two different instructional activities after an immersive virtual reality (IVR) field trip. The study showed that both groups demonstrated significant increases in affective learning, including increased self-efficacy, interest, STEM intentions, expectations, and intentions. Eight (8) articles reported positive learning outcomes in terms of *knowledge retention, knowledge gain, and content mastery*. For example, Matthews (2020)'s article explore how VFTs can be used to help students gain deeper understanding about glacial landscapes. The study reported that the VFT enhanced students' understanding of the content but also built their interdisciplinary skills, such as numeracy and evaluation skills. Three (3) studies (Lee et al., 2021; Norris et al., 2015; Puhek et al., 2012) mentioned that there were no significant changes in students' content learning.

In conclusion, the results to Research Question 2 highlights the significance of considering both affective and cognitive aspects in implementing VFT and aligning the learning outcomes. The predominance of studies reporting positive outcomes in both domains underscores the importance of a multifaceted approach to education. This approach not only enhances knowledge retention and mastery but also positively impacts student attitudes, motivation, and engagement. The findings align with educational research advocating for a holistic assessment of learning, emphasizing that emotional and psychological factors are as integral to the learning process as cognitive skills. The few articles noting no significant changes (Norris, et al., 2015; Puhek, et al., 2012; Woo-Hee, et al., 2021) in content learning further suggest the need for ongoing research and development of educational strategies that effectively integrate VFT with focus on the multiple dimensions of learning.

Research Question 3

Research Question 3 asks about activities/strategies used or planned involving VFTs in various subject areas in K-12 classrooms. Two types of interaction involving teacher and students are categorized into four levels (shown in Figure 1): 1) teacher-to-student interaction high with peer-to-peer interaction high (*n*=11), 2) teacher-to-student interaction high with peer-to-peer interaction low (*n*=6), 3) teacher-to-student interaction low with peer-to-peer interaction low (*n*=5), and 4) teacher-to-student interaction low with peer-to-peer interaction high (*n*=0). It seems that high levels of peer-to-peer interaction coincide with high levels of teacher-to-student interaction, however, high teacher-to-student interaction may not necessarily lead to high peer-to-peer interaction, indicating that teachers need to design specific activities to promote student interaction among themselves.

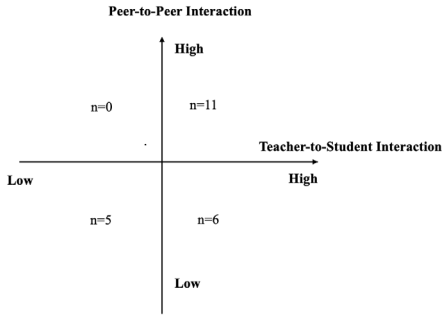

Figure 1. Teacher-to-Student and Peer-to-Peer Interaction Patterns

As shown in Table 4, in terms of activities/pedagogy involved, it seems that the majority of studies utilized a combination of a variety of pedagogical activities in which *preparatory teaching* (*n*=13), *peer collaboration* (*n*=9), *demonstration* (*n*=6) and *feedback* (*n*=6) seem to be the most popular ones. For example, Adedokun (2012) and colleagues designed a program to use VFTs to connect middle school students and university scientists. The team applied several pedagogical activities into the program, including peer interaction and peer-teacher interaction through asynchronous and synchronous communication, and connections to university experts. This shows that VFT can be integrated in collaborative learning environments with teachers and peers helping each other. It is noticeable that four studies (Delacruz, 2019; McPherson et al., 2021; Saha et al., 2022; Adedokun et al., 2012) also mentioned the involvement of outside experts as a part of the VFT design or VFT lessons. Among all pedagogical strategies, *teach back*

(Parmaxi et al., 2021) and *concept mapping* (Matthews, 2020) were used less frequently. This may be caused by less familiarity with the strategies or may indicate that these strategies are not completely aligned with the teaching objectives.

Table 4. *Teachers' Pedagogical Activities in Using VFTs*

Study Number	Demonstratio	Questioning	Discussion	Preparatory Teaching	Feedback	Concept Mapping	Teach Back	Community/Exp Connection	Peer Collaboratio
1	X			X					
2	X								X
3		X			X			X	
4				X	X				
5			X	X					X
6							X		X
7					X				
8					X				
9		X	X	X	X			X	
10				X		X			
11			X	X	X				X
12	X								
13						X			
14									X
15			X	X					X
16	X			X					
17	X	X		X					X
18	X		X	X				X	X
19				X					
20				X					
21				X					
22								X	X
Total	6	3	5	13	6	2	1	4	9

In conclusion, results to Research Question 3 reveal insightful trends regarding teacher-student and peer interactions. The alignment of high levels of teacher-to-student and peer-to-peer interactions was observed, suggesting that active teacher engagement tends to foster a collaborative learning environment. However, high teacher involvement does not automatically translate to increased peer-to-peer interaction, indicating a need for

teachers to intentionally design activities that encourage student collaboration. Regarding pedagogical strategies, VFTs are most effectively utilized in conjunction with a diverse range of teaching activities. Preparatory teaching, peer collaboration, demonstrations, and feedback are prominently used, highlighting VFTs' versatility and compatibility with collaborative learning models. The involvement of outside experts in some studies (Adedokun, et al., 2012; Delacruz, 2019; McPherson, et al., 2021; Saha, et al., 2022) underscores the potential of VFTs to extend learning beyond the classroom and provide expert insights, enhancing the learning experience. However, the less frequent use of teach-back and concept mapping strategies suggests either a lack of familiarity with these methods or a potential mismatch with the objectives of VFT-based teaching. This points to an area for further exploration and development in pedagogical approaches for VFTs. Overall, these findings indicate that VFTs are a valuable tool in diverse educational settings, promoting engagement and understanding through various interactive and collaborative strategies. The challenge and opportunity lie in exploring and optimizing the full range of pedagogical approaches to maximize the educational potential of VFTs.

SUMMARY OF FINDINS

In summary, the results from the three research questions on Virtual Field Trips (VFTs) across various dimensions show the potential and challenges in K-12 classrooms. Firstly, VFTs are shown to be particularly effective in subjects that benefit from visual and experiential learning, such as geography (Matthews, 2020), biology (Puhek et al., 2012), and climate change (Makransky & Mayer, 2022; Petersen et al., 2020), due to their ability to simulate complex and remote environments. This effectiveness is particularly pronounced at the secondary education level, where students' cognitive development aligns well with the demands of VFTs. However, there's an unexplored potential in expanding VFTs to younger age groups and subjects like history and English, indicating room for growth and adaptation in diverse educational settings. Secondly, the results emphasize the importance of integrating both affective and cognitive aspects in VFT education (Norris et al., 2015; Peterson, et al., 2020; Woo-Hee et al., 2021). The positive impact of VFTs on students' knowledge retention (Araiza-Alba et al., 2021; Makransky & Mayer, 2022), attitude (Woo-Hee et al., 2021; Norris et al., 2015), and engagement (Araiza-Alba et al., 2021; Calvert & Abadia, 2020; Lee et al., 2022) demonstrates the necessity of a holistic approach in education. This approach acknowledges that emotional and psychological factors are as crucial as cognitive skills in the learning process. The instances where VFTs did not significantly change content learning suggest a need for ongoing refinement in educational strategies to better integrate these multiple dimensions of learning.

Lastly, the interaction dynamics between teachers, students, and peers within VFT environments highlight the importance of active teacher engagement and well-designed collaborative activities. While high levels of teacher-student interaction often foster peer collaboration (Parmaxi, et al., 2021; Peterson, et al., 2020), this is not always the case, necessitating intentional pedagogical planning. The variety of teaching activities used in conjunction with VFTs, including the involvement of outside experts, points to the versatility and adaptability of VFTs in fostering an interactive learning environment. Nonetheless, the underuse of certain pedagogical strategies like teach-back and concept mapping suggests areas for further pedagogical research and development.

Overall, VFTs emerge as a valuable educational tool that, when effectively implemented, can significantly enhance the learning experience across various subject areas and educational levels. The key lies in harnessing their full potential through adaptive strategies that cater to the diverse needs of learners and align with the evolving technological landscape in education.

DISCUSSION

The reported results from this review enhances our understanding on the implementation of VFTs from the learning outcome and pedagogical perspectives. The findings suggest that VFTs can be used in various subjects across grade levels to promote learning, particularly affective and cognitive learning.

TEACHING: INTEGRATING WITH PEDAGOGICAL FOCUS

While this review generally concurs with prior studies on the use of general instructional technology in K-12 education (Aleshia et al., 2021, Merritt et al., 2022), suggesting that technology, including VFTs, can enhance student learning across various subjects and grades, we've noticed a scarcity of research focusing on the teaching pedagogy that lead to these positive outcomes. In the literature we examined, only about one-third of the articles detailed the pedagogical activities implemented in classrooms. This could be attributed to the fact that with VFTs being a relatively emerging new educational tool, many researchers and educators are in the early stages of experimenting integrating it into their curricula. Their focus has primarily been reported on exploring the "what" questions, that is, what can VFTs do to student learning, rather than delving into the “how” questions, that is, how to effectively implement VFTs into the teaching so that positive learning outcomes can be achieved.

When considering VFTs from the perspective of situated learning, the environment in which learning occurs is pivotal in shaping and enriching the experiences of learners. This applies to both the internal context of the VFT, like the virtual environments where students can engage and investigate, and the external classroom setting, encompassing the educational activities involved. The manner in which teachers integrate VFTs into their instruction plays a significant role in influencing the learning outcomes of students.

LEARNING: ADVOCATING HIGHER ORDER THINKING AND LEARNING

Secondly, a detailed examination of cognitive learning improvements reveals that most positive outcomes are centered on memorization and retention of content. For instance, Petersen et al., (2020) observed a notable enhancement in students' factual knowledge. Similarly, research by Makransky and Mayer (2022) indicated a boost in student knowledge retention, evident in both immediate and delayed post-tests. However, there are fewer instances where VFTs have been documented as enhancing students' advanced cognitive skills, such as analysis and synthesis, as classified by Bloom (2006). This advocates future application and integration of virtual field trip to examine the affordances of the design of virtual field trip to engage in higher order thinking skills.

DESIGNING: EMPOWERING TEACHERS AS VFT DESIGNERS

The review highlights a noteworthy aspect: the majority of VFTs have been developed by field experts other than teachers, often overlooking educational perspectives. The review includes just one instance (Delacruz, 2018) where teachers and students participated in VFT creation, while other studies (Saha et al., 2022; McPherson, et al., 2021) focus on VFTs designed by subject experts. Given the time-intensive nature and the need for advanced knowledge in educational technology, it is evident that VFT development may not be feasible for all teachers. However, we propose that teachers as instructional designers ponder the following key questions when they consider adopting VFTs in their teaching:

- What are my teaching goals/objectives?
- Which VFT or which sections of the VFTs aligns with my teaching objective(s)?
- Do my students have enough background knowledge (conceptually, culturally, and linguistically) to understand the VFT? If no, do I need to change to another VFT or do I need to design activities to build background knowledge?
- Do my students have prior experience with VFT platforms or technology? If not, what preparation is required, and how much time should be allocated for it?
- What during and after activities should I design to enhance learning and facilitate the collection of student performance data?

CONCLUSION: LIMITATIONS, IMPLICATIONS AND FUTURE RESEARCH

Though this review has been designed and implemented with the targeted research question in mind, certain limitations are still considered. The review covers studies from May 2012, so any empirical studies conducted before May 2012 were excluded. Furthermore, the particular design of the virtual field trip for different levels of learners is not addressed in this review. The main reason for this is that the review focuses on understanding the during gameplay sessions and does not cover their preparation activities.

The findings of the review implied that VFTs may be effective in subjects that benefit from visual and experiential learning, and they seem to be more suitable for adolescent students. Secondly, the results indicated that VFTs may lead to positive learning outcomes, both cognitively and affectively. Future research could look at assessing the long-term cognitive and affective impacts of VFTs would be valuable. This includes understanding how VFTs influence students' learning trajectories and interest in subjects over time.

Additionally, future research could implement comparative studies between traditional field trips and VFTs could provide deeper insights into their relative strengths and weaknesses. This could guide educators in making informed choices about which type of field trip to employ for different learning objectives.

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Appendix: List of papers chosen for the study

Study Number	Authors	Year	Article Title	Subject	Grade Level	Publication Journal
1	Woo-Hee, Kim, Kim, Hee-Soo, & Lim	2021	Students' reactions to virtual geological field trip to Baengnyeong Island, South Korea	Science	Secondary	ISPRS International Journal of Geo-information
2	Tutwiler, Lin, & Chang	2013	Determining virtual environment "fit": The relationship between navigation style in a virtual field trip, student self-reported desire to visit the field trip site in the real world, and the purposes of science education	Science	Secondary	Journal of Science Education and Technology
3	Saha, Tapuke, Kennedy, Tapuke, Hersey, Wright, Tolbert, Macfarlane, Leonard, Tupe, Ngaropo, Milroy, & Smith	2022	Use of "our supervolcano" virtual field trip to support bicultural classrooms in Aotearoa New Zealand	Science	Across multiple levels	Science Activities
4	Puhek, Perše, & Šorgo	2012	Comparison between a real field trip and a virtual field trip in a nature preserve: Knowledge gained in biology and ecology.	Science (biology& ecology)	Secondary	Journal of Baltic Science Education
5	Petersen, Klingenberg, Mayer & Makransky	2020	The virtual field trip: Investigating how to optimize immersive virtual learning in climate change education	Science	Secondary	British Journal of Educational Technology
6	Parmaxi, Athanasiou, & Demetriou	2021	Introducing a student-led application of Google Expeditions: an exploratory study	Language	Secondary	Educational Media International
7	Norris, Shelton, Dunsmuir, Duke-Williams, & Stamatakis	2015	Virtual field trips as physically active lessons for children: a pilot study	Social Studies	Elementary	BMC Public Health
8	Mead et al.	2019	Immersive, interactive virtual field trips promote science learning	Science	Secondary and college	Journal of Geoscience Education
9	McPherson, Frank, Pearce, & Hoffman	2021	Virtual field trips: Pivoting cross-curricular experiential learning to an online platform	Multisubject	Secondary	Science Teacher
10	Matthews	2020	It's virtually a glacier	Science	Secondary	Teaching Geography
11	Makransky & Mayer	2022	Benefits of taking a virtual field trip in immersive virtual reality: Evidence for the immersion principle in multimedia learning	Science	Secondary	Educational Psychology Review
12	Lin, Tutwiler, & Chang	2012	Gender bias in virtual learning environments: An exploratory study	Life skills	Secondary	British Journal of Educational Technology
13	Lee, Hsu, & Cheng,	2022	Do curious students learn more science in an immersive virtual reality environment? Exploring the impact of advance organizers and epistemic curiosity	Science	Elementary	Computers & Education
14	Hasenbein, Stark, Trautwein, Queiroz, Bailenson, Hahn, & Göllner	2022	Learning with simulated virtual classmates: Effects of social-related configurations on students' visual attention and learning experiences in an immersive virtual reality classroom	Life skills	Elementary	Computers in Human Behavior

Study Number	Authors	Year	Article Title	Subject	Grade Level	Publication Journal
15	Han	2021	Immersive virtual field trips and elementary students' perceptions	Multidisciplinary	Elementary	British Journal of Educational Technology
16	Han	2020	Immersive virtual field trips in education: A mixed-methods study on elementary students' presence and perceived learning	Literacy	Elementary	British Journal of Educational Technology
17	Dougherty Oliver, & Fergusson	2014	Pathways to space: A mission to foster the next generation of scientists and engineers	Social studies/history	Secondary	Acta Astronautica
18	Delacruz	2019	Building digital literacy bridges: Connecting cultures and promoting global citizenship in elementary classrooms through school-based virtual field trips	Social studies	Elementary	TechTrends
19	Cheng & Tsai	2019	A case study of immersive virtual field trips in an elementary classroom: Students' learning experience and teacher-student interaction behaviors	Social studies	Elementary	Computers & Education
20	Calvert, & Abadia	2020	Impact of immersing university and high school students in educational linear narratives using virtual reality technology	Social studies/history	Secondary	Computers & Education
21	Araiza-Alba, Keane, Matthews, Simpson, Strugnell, Chen & Kaufman	2021	The potential of 360-degree virtual reality videos to teach water-safety skills to children	Life skills	Elementary	Computers & Education
22	Adedokun, Hetzel, Parker, Loizzo, Burgess, & Paul Robinson	2012	Using virtual field trips to connect students with university scientists: Core elements and evaluation of zipTrips™	Science	Secondary	Journal of Science Education & Technology