You Don't Have to Feel Trapped: Virtual Field Trips During School Shutdowns –A Systematic Review and SWOT Analysis

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Abstract
The purpose of this systematic review and Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis is to examine the Virtual Field Trips, an important component of educational technology, to see how these can help ensure continuity of education (both formal and informal) in a safe manner, and how they can help address the unique needs of each learner and support diverse and inclusive education. This research systematically summarized existing literature published between January 2021 and December 2021, and search terms identified 1795 papers, from which 37 relevant articles met the inclusion criteria of the current review. Data extraction was initially conducted based on title, keywords, and abstract; it continued with a full-text analysis for the final set of 37 included studies. The results show that Virtual field trips can be useful to individuals who are unable to go on a real field trip in case of another national lockdown or in the 'new normal' and the 'next normal' post-pandemic era and due to other problems, such as climate change, as they allow students to travel to different areas without leaving their safe environment.

Keywords: Real Field Trip, Virtual Field Trip, Educational Technologies, SWOT Analysis, Covid-19 Pandemic

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Introduction

The COVID-19 outbreak disrupted normal life worldwide, and perhaps most notably affected education, Governments across the world endeavored to minimize its spread by adopting and implementing measures to limit social contact by closing public areas such as sports centers, museums, libraries, universities, etc., as this has been proven to be an effective way of minimizing the spread of the virus (Aslam, 2020). However, isolation policies and the closure of schools, colleges, and Higher Education institutions created a range of difficulties in education for students and teachers/lecturers (Daniel, 2020). Due to the Covid-19 restrictions, all affected countries were required to rapidly seek digital solutions to the continuation of education such as Educational Technologies (EdTechs) (Dhawan, 2020). EdTech, which is a combination of technology and education, includes software and hardware designed primarily to improve the quality of education and student-learning outcomes (King et al., 2016). The importance of EdTechs in education is not just about the power to engage students in cutting-edge and innovative approaches to learning and reducing costs; new learning formats, mobile apps, and online platforms have contributed tremendously to the development of the quality of the learning process, greatly improving individuals' access to education, while Cloud and online technologies bring the exciting potential for standardization of content (Pusca & Northwood, 2021; Moore, Jayme & Black, 2021). The probability of success in the transition to online learning is influenced by the user's purpose and the availability and practicality of EdTechs (Kemp, Palmer & Strelan, 2019). EdTech, if used effectively, gives opportunities to both students and teachers to mutually interact and collaborate with each other (Bower, 2019).

Educational Technologies are generally linked with online education, but this term is actually much more comprehensive. It combines all the ways to use technology in the education process, from interactive blackboards to Virtual Field Trips (VFTs), from Virtual Reality (VR) simulators for modelling surgical operations to virtual aerospace flight simulators (Ng, 2022; Han, 2020) and teaching quantum computation (Nita et al., forthcoming). The concept of field trips has also changed as a result of the increasing use of EdTechs (hardware, software, information and communications technology (ICT) systems, etc.), the use of the internet and, more recently, mobile technologies (Bowman et al., 2005). Through the rapid growth and expansion of new, practical, and affordable technologies and ICT in fieldwork, it has become critical for students and teachers to be more effective in the field (Cliffe, 2017). Such new technologies have the potential to further enhance the fieldwork environment and increase the effectiveness of ability development (Welsh et al., 2013). The use of technology in unexpected situations that pose health and safety risks, may prevent interruption of teaching and learning. In essence, VFTs try to capture the real-world environment of an area or location by combining various technological tools like photography, data, cartography, and geographic information systems (GIS) without the cost of being physically present at the location (Cliffe, 2017). VFTs integrate computer hardware and software to create real-time, networked multimedia settings that encourage students to collaborate and engage in activities interactively (Pugsley et al., 2022; Manning, 2019). The implementation of Real Field Trips (RFTs) is becoming increasingly complex due to concerns over finance, time, logistics, safety, and health pressures (Petcovic et al., 2014). If anyone, or indeed a combination of these factors exists, it may end this educational practice as it is not accessible to all students (Hall et al., 2004). VFTs can play an effective role in continuity of education as a safe and alternative option to, and indeed can be useful to children and young people who are unable to go on, RFTs due to the COVID-19 pandemic or other problems such as health or mobility constraints and in the context of desired travel restriction due to climate change. A VFT can

therefore contribute to the achievement of United Nations Sustainable Development Goal 4 (SDG), which declares that, by 2030, the world ought to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UNESCO, 2017). The purpose of this study is to analyse VFTs and RFTs in detail in terms of their Strengths, Weaknesses, Opportunities, and Threats (SWOT) and provides insight into how VFTs can be an effective option when RFTs are not available, or as a way to add value to resource intensive RFTs during school shutdowns in the age of climate change, natural disasters and epidemics.

Methods

In conducting this systematic literature review, this study followed the guidelines proposed by Kitchenham (2004). The search process used in this study is described in Figure 1 below.

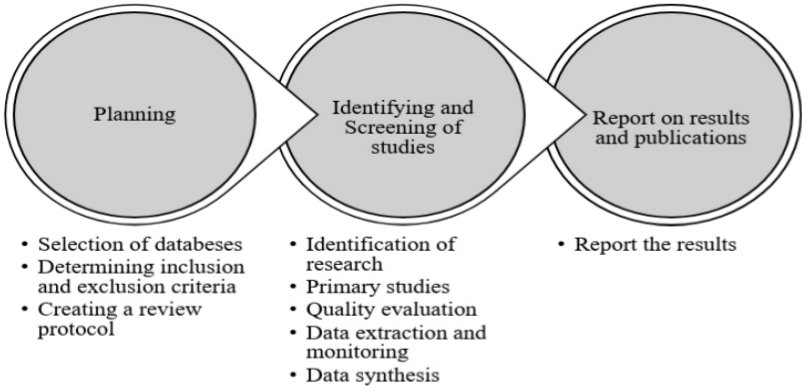
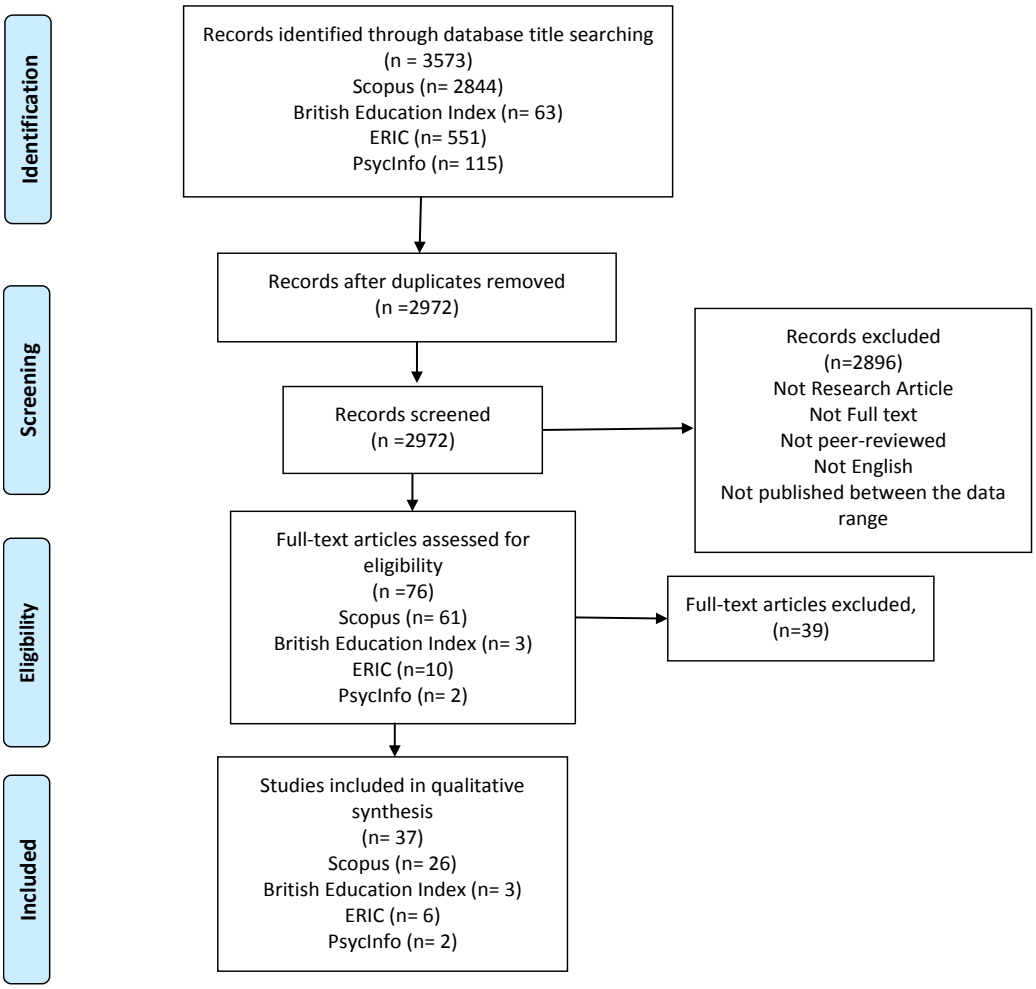


Figure 1. Systematic review process adapted from Kitchenham (2004)

In order to begin the search process, main search terms were first defined. The search string was composed of three main terms: "Real Field Trips", "Virtual Field Trips" and "Hybrid Field Trips". Each main term was expanded into multiple synonyms in the second step. Synonyms for real field trips and virtual field trips included 'school excursion' OR 'class trips' OR 'day trip' OR 'educational excursion' OR 'school trip' OR 'school outing' OR 'virtual field trips' OR 'virtual reality field trips' OR 'hybrid field trip'. In the third step, the search terms were connected using the logical operators "AND" and "OR", where "AND" referred to the two main components of the search string, while "OR" referred to similar keywords and phrases. In the fourth step, the following databases were searched: Scopus, British Education Index, ERIC and PsycInfo. A total of 3573 peer-reviewed articles in English were included in the first set of searches (see figure 2 below). The data parameters were set to include studies from January 2021 to December 2021 to gather up-to-date data. Four screening stages were used to select primary studies from the full list of candidate publications. In the first stage, several criteria were initially applied to exclude studies, including those less than three pages in length, not written in English, articles that are not related to RFTs and VFTs. After this stage of the screening, 37 articles ([1], [2], [3] [8], [13], [14], [15], [16], [17], [19], [20], [21], [22], [23], [26], [27], [28], [29], [37], [39], [42], [44], [45], [49], [50], [51], [52], [55], [58], [59], [60], [61], [62], [63], [67], [68], [69]) were selected for full text assessment. The second stage of the screening process involved reading title, keywords, and abstract to identify studies that are relevant to RFTs and VFTs that had been peer reviewed in an educational context. The final stage involved reading the full text in detail. During this stage, in-depth criteria were required to capture primary studies relevant to the research purposes of this study. The total of 37 studies obtained at the end of all these

processes were examined in depth using a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. There has been a rapid development of new and more powerful EdTech (particularly since the Covid-19 pandemic), and governments are making substantial investments in these technologies. By providing comprehensive perspective in light of internal and external analysis of any EdTech, SWOT analysis contributes to achieving the purpose of these investments and to ensure efficiency in the output of EdTech that are used throughout the educational process at any stage. Therefore, this study classifies VFTs based on SWOT analysis to provide internal and external information to individuals and institutions seeking to use VFTs.



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and MetaAnalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Figure 2. PRISMA flow diagram showing the result of the search and screening process

Data Extraction and Analysis

Following the selection protocol, a final total of 37 selected studies were selected for review. Next, a database was developed to extract and aggregate information to then conduct an in-depth review via coding. The data were organized based on the country where the study was conducted, research theme, method of selected studies, SWOT analysis, education level, impacts of the field trips, discipline of selected studies (See Table 1). The articles were read thoroughly, related articles are classified under these sections. As shown in Table 2, 45.9%

(n= 17) of the studies selected for systematic review and SWOT analysis focused on higher education students or studies aimed to contribute to this field. A total of 51.4% (n=19) of the selected studies were in RFTs, 45.9% (n=17) in VFTs, and 2.7% (n=1) in HFTs. USA has the highest percentage of selected articles based on the country where the study was conducted, which is 40.5% (n=15), followed by Germany with 10.8% (n=4), Canada with 5.4% (n=2), Australia with 5.4% (n=2), and South Korea with 5.4% (n=2). The other countries in Table 2 each have a 2.7 (n=1) percentile. Considering the discipline of the selected articles, most studies were conducted in the field of education with 24.3%, followed by science with 13.5% and geoscience with 10.8%. After extracting those sections, they were read again to obtain and separately classify the parts related to each type of field trips. The results of this classification are shown in the SWOT analysis findings section.

Table 1. Coding Process

Categories	**Sub-categories**
Country	*Country*
1 *Research theme*	A Real Field Trips B Virtual Field Trips C Hybrid
2 *Method of research* **2.1.** Real Field Trip **2.2.** Virtual Field Trip **2.3.** Hybrid Field Trip	A Quantitative B Qualitative C Review D Mixed Method E Design-oriented
3 *SWOT Analysis* **3.1.** Real Field Trip **3.2.** Virtual Field Trip **3.3.** Hybrid Field Trip	A Strength B Weaknesses C Opportunities D Threat
4 *Education Level* **4.1.** Real Field Trip **4.2.** Virtual Field Trip **4.3.** Hybrid Field Trip	A Early Years Education B Primary school C Secondary school D Further education E Higher education F Post-graduate degree (Masters or PhD) G Teachers/lecturers/Professors (including preservice teachers) I Adults or Public or professionals J None
5 *Impacts of the field trips* **5.1.** Real Field Trip **5.2.** Virtual Field Trip **5.3.** Hybrid Field Trip	A History learning B Safety and Security C Social or/and professional connections D Hands-on experience or inquiry-based learning E Learn a specific topic F Provide a good alternative during restriction periods G Reduce accessibility barriers H Improve existing field work with better before-hand preparation, I Social-emotional or academic or behavioral effects

	J Career selection or professional knowledge K Place engagement L Information-rich or immersive or multimodal or interactive environments M Environmental knowledge or connection to nature or positive scientific attitude N Practice and acquire skills O Time saving or low cost
6 *Discipline of selected studies* **6.1.** Real Field Trip **6.2.** Virtual Field Trip **6.3.** Hybrid Field Trip	A Geoscience B Health C Education D Biology E Science F Physics G Social Science H Tourism I Geology J Art K Game L Geography M Law N Anthropology

Table 2. Characteristics of the included studies

Article	Country	Research theme	Method of research	Swot Analysis	Education Level	Impacts of the field trips	Field of articles
Anderson (2021)	USA	1A	2.1.B	3.1.B	4.1.J	5.1.D	6.1.E
Ando et al. (2021)	Japan	1B	2.2.A	3.2.A	4.2.E	5.2.B	6.2.B
Arcodia et al. (2021)	Australia	1A	2.1.A	3.1.C	4.1.E	5.1.C	6.1.H
Cagalanan & Whitesides (2021)	USA	1B	2.2.B	3.2.C	4.2.E	5.2.L; 5.2.F; 5.2.E; 5.2.D	6.2.L
Duncan (2021)	USA	1A	2.1.A	3.1.A; 3.1.B	4.1.G	5.1.A	6.1.C
Evelpidou et al. (2021)	Greece	1B	2.2.B	3.2.A; 3.2.B; 3.2.C; 3.2.D	4.2.E	5.2.E	6.2.I
Fadilloh, Rustaman & Sanjaya (2021)	Indonesia	1A	2.1.A	3.1.A; 3.1.C	4.1.C	5.1.F; 5.1.G; 5.1.H	6.1.F
Florick et al. (2021)	USA	1A	2.1.A	3.1.C	4.1.B	5.1.I	6.1.J
Follari et al. (2021)	USA	1A	2.1.B	3.1.C	4.1.B; 4.1.I	5.1.E; 5.1.D; 5.1.I	6.1.E
Gavin (2021)	USA	1A	2.1.B	3.1.C	4.1.E	5.1.D; 5.1.A	6.1.G
García-Vela et al. (2021)	Spain	1B	2.2.B; E	3.2.C	4.2.E	5.2.B	6.2.A
González-Herrera & Giralt-Escobar (2021)	Mexico	1A	2.1.D	3.1.A	4.1.E	5.1.D	6.1.H
Goralnik et al. (2021)	USA	1A	2.1.D	3.1.C	4.1.C	5.1.K; 5.1.I;	6.1.C
Grinfelde & Veliverronena (2021)	Latvia	1A	2.1.D	3.1.C	4.1.E	5.1.J: 5.1.E	6.1.H

Table 2. (continued)

Article	Country	Research theme	Method of research	Swot Analysis	Education Level	Impacts of the field trips	Field of articles
Han (2021)	South Korea	1B	2.2.B	3.2.C; 3.2.D	4.2.B	5.2.B; 5.2.C	6.2.C
Harrington et al. (2021)	USA	1B	2.2.B; E	3.2.A	4.2.I	5.2.L	6.2.K
Holgersen (2021)	Sweden	1A	2.1.B	3.1.A	4.1.G	5.1.	6.1.L
Hoover (2021)	USA	1A	2.1.D	3.1.C	4.1.C	5.1.M	6.1.C
Middlebrooks, & Salewski, (2021)	USA	1A	2.1.B	3.1.C 3.1.D	4.1.E	5.1.M; 5.1.E	6.1.D
Krantz & Downey (2021)	USA	1A	2.1.C	3.1.C	4.1.J	5.1.D	6.1.J
Lee et al. (2021)	South Korea	1B	2.2.A; E	3.2.A; 3.2.B; 3.2.C	4.2.C	5.2.M; 5.2.I	6.2.A
McPherson et al. (2021)	Canada	1B	2.2.B	3.2.C	4.2.C	5.2.D	6.2.E
Mohring & Brendel (2021)	Germany	1B	2.2.B; E	3.2.A	4.2.E	5.2.D; 5.2.L	6.2.L
Ní Drisceoil (2021)	UK	1B	2.2.C	3.2.A	4.2.E	5.2.E; 5.2.J; 5.2.C	6.2.M
Ordon, Bartelheimer & Asshoff (2021)	Germany	1A	2.1.D	3.1.B; 3.1.C	4.1.E	5.1.C; 5.1.M	6.1.C
Patiar et al. (2021)	Australia	1B	2.2.A	3.2.A; 3.2.B	4.2.E	5.2.L; 5.2.D; 5.2.J; 5.2.E	6.2.H
Peace, Gabriel & Eyles (2021)	Canada	1B	2.2.B	3.2.A	4.2.E	5.2.D; 5.2.L; 5.2.G	6.2.A
Price & de Ruiters (2021)	South Africa	1B	2.2.B	3.2.C	4.2.E	5.2.F; 5.2.E	6.2.N
Schneiderhan-Opel & Bogner (2021)	Germany	1A	2.1.A	3.1.C	4.1.C	5.1.M; 5.1.D	6.1.D

Table 2. (continued)

Article	Country	Research theme	Method of research	Swot Analysis	Education Level	Impacts of the field trips	Field of articles
Schulze et al. (2021)	USA	1C	2.3.D	3.3.A; 3.3.B	4.3.E	5.3.D; 5.3.E	6.3.E
Soto et al. (2021)	Peninsular Malaysia	1B	2.2.E	3.2.A; 3.2.B	4.2.J	5.2.N; 5.2.G; 5.2.L	6.2.A
Sotomayor (2021)	Peru	1A	2.1.B	3.1.C	4.1.I	5.1.C; 5.1.J; 5.1.K	6.1.H
Tigert, Fotouhi & Kirschbaum	USA	1A	2.1.B	3.1.C	4.1.G	5.1.D; 5.1.E; 5.1.N	6.1.C
Trinh (2021)	USA	1A	2.1.B	3.1.C	4.1.C	5.1.A; 5.1. E	6.1.C
Wolf et al. (2021)	Germany	1B	2.2.D; E	3.2.A	4.2.E	5.2.F; 5.2.L; 5.2.I	6.2.C
Yacobson et al. (2021)	Israel	1B	2.2.A	3.2.D	4.2.B	5.2.B	6.2.E
Zhao et al. (2021)	USA	1B	2.2.A; E	3.2.C	4.2.E	5.2.I; 5.2.L	6.2.C

After the systematic review, RFTs and VFTs were analyzed via SWOT analysis. The SWOT model allows experts/researchers to classify internal factors such as strengths (features of a task/project that give it an advantage over others) and weaknesses (features that put one task/project at a disadvantage relative to others), and external factors such as opportunities (factors in an area that a project/task could exploit to its benefit) and threats (factors in an area that could cause concern for a task/project) relating to the choice to take or implement, thereby comparing opportunities and threats with strengths and weaknesses (Humphrey, 2005).

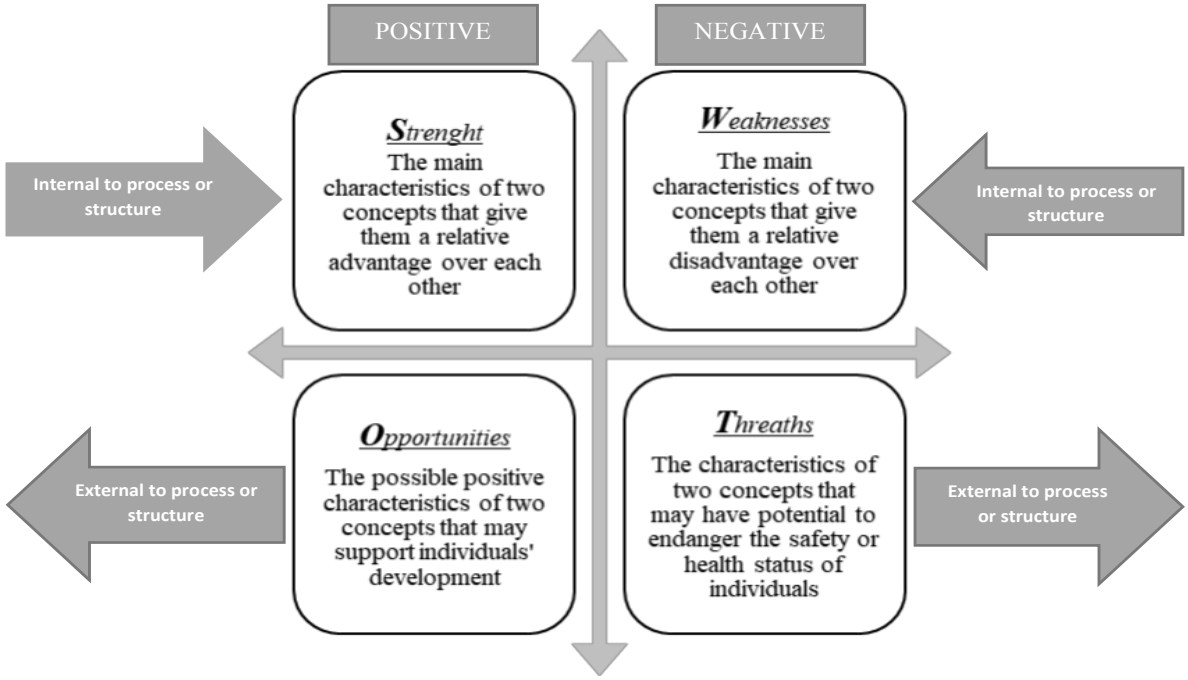


Figure 3. Schematic representation of SWOT analysis

For this study, each stage of the SWOT analysis was carried out as follows: the main features and strengths of RFTs and VFTs that give them a relative advantage over each other were classified under the heading 'Strengths'; the negative characteristics/features that put RFTs and VFTs at a disadvantage relative to each others were classified under the heading 'Weaknesses'; the possible positive factors that RFTs and VFTs may offer to individuals/participants and may support their development were categorized under the title of 'Opportunities'; finally, the features of RFTs and VFTs that may have potential to endanger the safety or health status of students/participants were evaluated under the title 'Threat' (see Fig. 3).

Findings

Strengths

A Real Field Trip is not a break from school, but rather an opportunity to have an authentic, real-life, experiential learning experience outside the classroom. The RFT experience provides students with the opportunity to deepen their understanding of a topic they have been studying in the classroom (Duncan, [13]). Through direct observation of the study area, RFTs assist individuals in understanding the relationship between inductive and deductive pathways of any knowledge, and between such knowledge's sensory and rational components (González-Herrera & Giralt-Escobar, [21]). Information and sources of knowledge are more often derived from seeing, hearing, and experiencing than from reading and, therefore, it is impossible to replicate all aspects of in-person field trips without going into the field (Holgersen, [28]; Schulze et al., [59]; Ní Drisceoil, [49]). It is also possible for students to be actively involved in planning their own learning experiences, so that they can develop memorable experiences during the three key moments of a field trip (before, during, and after activities) (González-Herrera & Giralt-Escobar, [21]). A field trip is based on outdoor learning, so it requires cooperation between teacher and students to run smoothly (Fadilloh, Rustaman & Sanjaya, [15]).

In open access VFTs, on the other hand, people from different countries/nationalities are able to participate simultaneously and gain a wide range of field experiences (Peace, Gabriel & Eyles, [52]). There are no special requirements to use this tool, and it can be accessed from any device that has an internet connection, such as a computer, tablet, or smartphone; thus, it can be used in any place such as a classroom, office, home, etc. (Evelpidou et al., [14]). In addition to providing flexible and democratized delivery of education, a VFT platform contains more content and information than students can absorb in one visit, and indeed is available at any time to be used multiple times (Patiar et al., [51]). The flexibility of VFTs allow students to learn at their own pace, hence they can practice and acquire skills by repeating VFTs without being constrained by time or space (Soto et al., [60]; Lee et al., [39]). VFTs are also useful when it is not possible to visit certain sites due to time, safety and health concerns, financial constraints, or weather conditions (Evelpidou et al., [14]). According to Ando et al., [2], indoor positioning technology and low-cost dust sensors can help visualize hazardous material exposure in order to reduce exposure and prevent health problems. VFTs make it possible for marginalized students to participate in fieldwork that would otherwise be impossible. This is so because VFTs do not exclude students from participating who have social, cultural, or physical impairments, and/or mental health issues (Peace, Gabriel & Eyles, [52]). A VFT's effectiveness depends on the quality of the material used, and there is a direct correlation between the quality of the VFTs and the available technology, resources, and time (Soto et al., [60]). With high-quality VFTs, users explore the location or area of interest in greater detail with high-resolution images, which provide quality input. Information can be further enhanced by organizing it along a virtual pathway, as this improves the ability to simulate an RFT (Soto et al., [60]). A 360o model-based VFT, which also allows the viewer to view and explore a photorealistic object from multiple locations within the model, is a promising learning activity, which on the one hand could replace RFTs in pandemic situations such as with Covid-19, whilst on the other could provide the basis for self-directed learning as part of a library of 360o models (Wolf et al., [67]). It is also becoming increasingly common to use VR in education, such as for demonstrating problems or building the ability to cope with unknown situations (Mohring & Brendel, [45]). The three-dimensional, real-time interactive visualization of GIS data resulting from this artifact creates a virtual model of the plants, which when combined correctly on a terrain produces an accurate and highly realistic virtual landscape – it is like walking into a diorama or exhibit in a natural history museum (Harrington et al., [27]).

Weaknesses

The planning and management of RFTs require considerable time and effort (Duncan, [13]). Although teachers often lack confidence when teaching outdoors, they need to be incredibly thoughtful when planning trips (Ordon, Bartelheimer & Asshoff, [50]; Duncan, [13]). Due to time and distance constraints, accessibility issues, accommodation issues, costs, cold weather, and the steepness of the field site, RFTs are not always possible (Schulze et al., [59]; Lee et al., [39]; Anderson, [1]). In hospitality sites, for example, challenges include accommodating increasingly large cohorts of students, as well as providing access to front and back of house operations and providing students with guidance and information (Patiar et al., [51]). The bus schedule can be inconvenient or not on time, or the bus stop might be far from the field (Schulze et al., [59]). There may be the need for an alternative means of transportation for students who might have difficulties getting to the field sites on their own, or from being able to explore the field sites through Google Maps/Google Street View (Schulze et al., [59]).

In similar to RFTs, VFTs have also a number of features that make them in disadvantage situations. Compared to RFTs, a VFT is less effective at imparting field-based skills (Soto et al., [60]). VFTs cannot convey the non-visual and aural sensory perceptions that are crucial in real fieldwork settings, such as smell and touch (Soto et al., [60]). These trips also appear to lack one of the main aims of trips, namely discovering something new and/or interesting. In contrast to RFTs, VFTs are not able to strengthen a student's observation skills since they would not be able to observe the site from different angles and are also not fully capable of replicating RFTs' ability to test students' decision-making skills (Evelpidou et al., [14]). Moreover, through an online platform, it may not be possible to view or recognize a small or detailed landform or feature in detail. The display size of the screen contributes to more solitary work and reduced group activity, and this decreases the benefits of group interaction (Soto et al., [60]). Despite the fact that VFTs are designed to be interactive, the interaction between the participant and the instructor is something that technology cannot replicate, and this poses a significant problem for the student as it reduces the social component of a trip (Soto et al., [60]). Also, due to the pace at which technology moves, educators need to spend a lot of time and resources developing VFT components (Patiar et al., [51]). This can result in products being perceived as "dated" or obsolete within relatively short periods of time.

Opportunities

Through active and exploratory learning, short-term field trips are widely used by teachers to provide students with new knowledge and experiences (Hoover, [29]). Students can gain an enhanced understanding of landscapes, places, and events if they are given the opportunity to engage with them in an interdisciplinary, sensory-rich, self-directed way during short-term trips (Goralnik et al., [22]). Excursions to sporting events, for example, may be the most beneficial to players since they are able to observe "systematic scientific" baseball on its home soil, for instance, and to better comprehend the racial issues affecting their compatriots (Gavin, [20]). As part of these kind of trips, individuals learn how to recognize their differences, name their biases, and discuss social injustices with one another (Trinh, [63]). Participating in RFTs can also help students succeed in their classes in the short term but provide them with a sense of empowerment and self-confidence in the long term (Sotomayor, [61]; Arcodia et al., [3]). Educating people about the environment in natural settings through RFTs, which allow for direct contact with nature, can increase environmental knowledge and potentially influence environmental attitudes (Hoover, [29]; Schneiderhan-Opel & Bogner, [58]). RFTs enable them to identify geological structures and landforms and understand their formation processes (Evelpidou et al., [14]). A highway traversing a 7,000-foot altitude offers students the opportunity to observe geological structures and discuss related dating information (Follari et al., [17]). Students can develop their sense of curiosity for nature and spark their passion for biology by spending time outside observing and collecting specimens (Middlebrooks & Salewski, [44]). This sparks their curiosity for nature, opens their eyes to the sheer magnitude of biodiversity, and fuels their future passion for biology in the longer term. Prospective biology teachers may also benefit from field trip-oriented courses by increasing their cognitive-affective parameters of interest and self-efficacy expectations (Ordon, Bartelheimer & Asshoff, [50]).

As learners gain an awareness that place is not just background but a storied context in which they take part, they explore what they value from multiple perspectives, compare observations from different locations – they cultivate empathy and vital skills that are applicable beyond the field trip itself (Goralnik et al., [22]). These field trips help students to examine the spiritual issues and reactions of different faiths and stimulate empathy by

introducing them to the history, literature, arts, etc., that are inspired by certain events (Grinfelde & Veliverronena, [23]). As a result of exposure to multiple high-quality or arts-based field trips, students are able to make better academic progress, improve their social and emotional well-being, as well as engage more in school activities (Florick et al., [16]). Even one museum visit contributes significantly to a student's visual arts education at school since it boosts four capacities that will carry over into their lives after graduation: creative thinking, empathy, critical thinking, and curiosity (Krantz & Downey, [37]). During these trips, educators engage students in instructional discourses or purposeful educator-student dialogues in order to create new understandings through co-construction (Tigert, Fotouhi & Kirschbaum, [62]). As a follow-up to the trip, educators can continue engaging students by soliciting their thoughts and ideas regarding any topic like satellite and manufacturing technologies (McPherson et al., [42]). During the preparation phase, data can also be gathered on multiple intelligences (musical, bodily-kinesthetics, naturalistic, etc.), and student scientific reasoning can be used to adjust the level of difficulty of the task according to their abilities (Fadilloh, Rustaman & Sanjaya, [15]).

A virtual experience, on the other hand, can impact learning or behavior in a lasting way and can bring a positive scientific attitude as a component of an affective learning process (Lee et al., [39]; Price & de Ruiters, [55]). It is possible to use immersive VFTs to provide engaging learning experiences in a classroom by making students feel as though they are in a virtual space, and by making them feel as if they are experiencing reality in a virtual space (Han, [26]). Compared to less immersive systems such as desktop VR, long-term use of VR may maintain student engagement and satisfaction and compensate for the initial lack of objective learning outcomes (Zhao et al., [69]). VR can also help improve RFTs. It represents a way to offer a first glance of what a place is like, the risks it poses, and the areas to observe; it represents a form of virtual briefing. In this way, students do not have to worry about getting lost or having trouble listening to the briefing in the field when there is wind, cold, and other adverse circumstances (García-Vela et al., [19]). It is also possible for VFTs to decrease the cost of international learning opportunities, both in terms of travel and tuition (Cagalanan & Whitesides, [8]). They can also ease the time burden placed on students interested in participating and make international learning more accessible to upper-level students. The benefits of VFTs are that they allow individuals to gain introductory knowledge before departure, identify specific interdisciplinary research opportunities, and develop relationships with peers and faculty. As a result of global uncertainty, they eliminate the "all-or-nothing" aspect of learning outcomes associated with standalone international learning opportunities (Cagalanan & Whitesides, [8]).

Threat

RFTs are important to students' education but cannot be conducted due to the Covid-19 pandemic (Evelpidou et al., [14]). During such a pandemic, travel and working together can give rise to a number of unique issues. For example, during the current pandemic, students were required to be with someone at the site but encouraged to travel separately and wear face masks at all times when in close contact. On site, however, there was considerable chance for students to spread the virus, and this might obviously result in associated health problems. Despite the fact that no locations are going to be completely free of hazards, it is important to identify likely hazards and ensure that students are aware of them. Rip currents, violent wave action, high crime rates, or unstable terrain are just a few examples of serious hazards that students may also encounter (Middlebrooks & Salewski, [44]). Safety briefings

are an important tool for identifying hazards and alerting students but are often used to limit liability as well (Middlebrooks & Salewski, [44]).

Using group information, educational institutions can target students with different types of advertisements, or reject students based on school and class characteristics. Additionally, such group profiling increases the risk of re-identification due to the possibility of linking data sets in new ways. The modern digital learning environment collects and analyses a large amount of data that can be utilized to improve their design as well as to develop "intelligent" mechanisms for individualized learning (Yacobson et al., [68]). The number and variety of learning analytics applications is growing rapidly, demonstrating the potential of this technology in this regard. The development of this field relies on data and an ecosystem of interoperable technologies to process it, so data is being exchanged between a wide range of third-party applications. Students' privacy and ethical use of student data are major concerns due to the rapidly growing collection of student data, its transfer between entities, and its use in making various decisions (Yacobson et al., [68]). It is possible that the pandemic will have a long-term effect on education systems worldwide, moving learning towards, if not heavily into, the digital realm. Due to the increase in time students spend in learning environments that are subject to automatic data collection, privacy safeguards for big data are essential for the use of big data in education. Immersive VFTs may have a number of disadvantages due to the increase in time students spend in learning environments, including collisions in the classroom, motion sickness, and social isolation. Prolonged use can result in addiction confusion about reality, eye damage, and reduced novelty (Han, [26]).

Discussion

Virtual Field Trips, explained as computer-based environments that allow students to virtually visit an area without having to leave the classroom or home, are seen as an innovative solution to overcome the challenges of Real Field Trips (Mead et al., 2019), especially during the restrictions associated with Covid-19. Using computer visualization techniques, VFTs give possible advantages for education, such as providing a preview or review of RFTs, providing access to inaccessible areas, presenting scenes from various angles and scales, enriching learning experiences, as well as helping to understand complex processes through additional and supplementary explanations and information. VFTs are not proposed to replace RFTs but could well help bring the trips into the classroom or home if the barriers to RFTs are insurmountable.

With their ability to place students in real learning settings, RFTs are frequently used for experiential learning (Krakowka, 2012). Experiential learning theory describes how knowledge is acquired through the transformation of experiences (Kolb, 1984). Dewey (1897) and Kolb (1984) emphasized that learning is a multi-linear, dynamic, and cyclical process because experiences continuously create and change thoughts, interests, and attitudes. Learning is an important part of the adaptation process in individuals' lives and shows its presence in all phases of life (Kolb & Kolb, 2009). From this point of view, experiential learning proposes a constructivist learning theory, where individuals' personal and social knowledge and experiences are shaped both collectively and constantly. By involving students as active participants in field trips and pre- and post-trip activities, field trips provide the opportunity to directly observe, examine, and scaffold knowledge of teaching materials in the physical world (Krepel & DuVall, 1981). That is, field trips not only support students' experiential learning through exploration, but also enable them to gain first-hand experience

and understanding of specific learning themes, and to establish a connection between existing knowledge and newly acquired knowledge.

The closure of schools caused by the pandemic has hindered the experience-based learning of many students and their scaffolding of knowledge through field trips. One solution to enabling a wider audience to reach field trips during the pandemic and bringing experiential, kinesthetic field trips lie in the continued advances in EdTechs such as through VR technologies. VR simulates real-time situations and makes it available to individuals through computer/communication devices. Some research findings have shown that simulations, games, and VFTs significantly increase student motivation, interest, and participation (Makransky et al., 2019). Studies on VFTs used in a wide variety of fields, including biology, engineering, medicine, geography, and geology, showed that students enjoy using VFTs and that researchers have seen gains in attention in the material through interaction and immersive experience compared to traditional learning (Friess et al., 2016). It was recommended to incorporate multimedia learning principles, such as coherence or segmentation principles, into the design of immersive VR content to ensure positive improvements in learning outcomes. Together with collaborative learning activities, VFTs facilitate interaction between peers in a particular group or between peers in different groups in any part of the world. Collaboration in the process of immersive VFTs not only promotes the zone of proximal development of students over peer learning but can also solve the problems of low social interaction perceived by students in earlier studies (Han, 2020). Piaget (1970) and Vygotsky (1978) highlighted that students build shared knowledge and understanding together by building on ideas through interacting with each other. Recent advances in technology allow researchers and practitioners to develop more interesting and interactive VFTs using advanced tools. Although these developments, as a result of new technologies, have provided flexibility to VFTs, there are various factors that need to be considered, and those that may threaten the success of VFTs are also examined in this study. Many websites are temporary, a site might go down, or quality control might not be regularly performed, students can easily get lost in these sites, and not every student can benefit from VFTs equally (being located in rural areas or due to socio-economic status). These show that educators and parents need to be very careful in their preparation before the use of VFTs.

Conclusion

Although the Covid-19 pandemic made the world aware of the risks of traveling abroad, and indeed the uncertainty in even planning to go abroad, and the closure of educational institutions/schools and disruption in education, such risks and uncertainties are not new. Natural disasters, especially in the age of climate change, political unrest, and epidemics, are challenges that may be present at any given place and time. The pandemic can be considered the first signs of disruption in the traditional education system globally. In the 'new normal' post-pandemic era, Educational Technologies have played a vital role – as they did during the pandemic – and they will continue to play this role for the ‘next normal' post-pandemic era. The use of innovative and problem-solving methods like VFTs in education can help ensure continuity of education (both formal and informal) in a safe manner, and how they can help address the unique needs of each learner and support diverse and inclusive education. In this study, using systematic analysis, RFTs and VFTs were analyzed in depth and the findings were supported via SWOT analysis. Both forms of field trip have their particular strengths and weaknesses, opportunities and threats. Where one lacks, it is important that the other can step in. In other words, by using RFTs and VFTs together, one can ensure that any shortcomings are addressed and thus the efficiency of field trips and their benefits to students

are increased. A combination of RFTs and VFTs can provide a richer learning experience than having fewer RFTs or VFTs. It is important to have an alternative option in unexpected situations that would otherwise prevent education and teaching from continuing in order to minimize disruptions to education. In special cases (such as Covid-19) where RFTs cannot take place or students have limited opportunities to attend, VFTs offer an alternative to RFTs and can support the development of students in such situations.

References

[1] Anderson, C. (2021). Field Trips Last a Lifetime Breadcrumb. *The Science Teacher, 88*(3), 17.

[2] Ando, H., Sekoguchi, S., Ikegami, K., Yoshitake, H., Baba, H., Myojo, T., & Ogami, A. (2021). Combining Indoor Positioning Using Wi-Fi Round Trip Time with Dust Measurement in the Field of Occupational Health. *Sensors, 21*(21), 7261. DOI: 10.3390/s21217261

[3] Arcodia, C., Novais, M. A., Cavlek, N., & Humpe, A. (2021). Educational tourism and experiential learning: students' perceptions of field trips. *Tourism Review, 76*(1), 241-254. https://doi.org/10.1108/TR-05-2019-0155

[4] Aslam, F. (2020). COVID-19 and Importance of Social Distancing. *Preprints, 2020040078*, 1–6. doi: 10.20944/preprints202004.0078.v1

[5] Bower, M. (2019). Technology-mediated learning theory. *British Journal of Educational Technology, 50(*3), 1035-1048. https://doi.org/10.1111/bjet.12771

[6] Bowman H., Van Den Hoof B., Van De Wijngaert L., & Van Dijk J. (2005). *Information and Communication Technology in Organizations*. London: Sage.

[7] Bruner, J. S. (1966). *Toward a theory of instruction* (Vol. 59). Harvard University Press.

[8] Cagalanan, D., & Whitesides, C. J. (2021). Integrated International Field Trips Maximize Accessibility and Preserve Learning Value in an Age of Uncertainty. *The Geography Teacher, 18(*3-4), 146-149. https://doi.org/10.1080/19338341.2021.1939096

[9] Cliffe, A. D. (2017). A review of the benefits and drawbacks to virtual field guides in today's Geoscience higher education environment. *International Journal of Educational Technology in Higher Education, 14(*1), 1-14. DOI 10.1186/s41239-017-0066-x

[10] Daniel, S. J. (2020). Education and the COVID-19 pandemic. Prospects, 49(1), 91-96.

[11] Dewey, J. (1897). The psychology of effort. *The Philosophical Review, 6*(1), 43-56.

[12] Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of educational technology systems, 49*(1), 5-22. https://doi.org/10.1177/0047239520934018

[13] Duncan, K. E. (2021). The possibilities of plantation field trips as sites of racial literacy. *Multicultural Education, 28*(1/2), 2-8.

[14] Evelpidou, N., Karkani, A., Saitis, G., & Spyrou, E. (2021). Virtual field trips as a tool for indirect geomorphological experience: a case study from the southeastern part of the Gulf of Corinth, Greece. *Geoscience Communication, 4*(3), 351-360. https://doi.org/10.5194/gc-4-351-2021, 2021

[15] Fadilloh, H., Rustaman, N. Y., & Sanjaya, Y. (2021, March). Designing a field trip: The role of multiple intelligence and scientific reasoning. In *Journal of Physics: Conference Series* (Vol. 1806, No. 1, p. 012149). IOP Publishing.

[16] Florick, L., Greene, J. P., Levenberg, R., & Pogue, R. (2021). The benefits of multiple arts-based field trips. *Phi Delta Kappan, 102*(8), 26-29. https://doi.org/10.1177/0031721721101393

[17] Follari, L., Larsen, J., Marquardt, C., & Goldman, M. (2021). Taking learning to new heights: Exploring ecology, state history, and geology through a field trip to 4,200 meters (14,000 feet). *Science Activities, 58*(1), 34-42. https://doi.org/10.1080/00368121.2021.1885335

[18] Friess, D. A., Oliver, G. J., Quak, M. S., & Lau, A. Y. (2016). Incorporating "virtual" and "real world" field trips into introductory geography modules. *Journal of Geography in Higher Education, 40*(4), 546-564. https://doi.org/10.1080/03098265.2016.1174818

[19] García-Vela, M. T., Borja-Bernal, C. P., Jordá-Bordehore, L., Medinaceli-Torrez, R., Loaiza, S., & Falquez, D. A. (2021, August). Teaching rock mechanics using Virtual Reality: laboratory practices and field trips during the confinement of the Coronavirus COVID-19 in Ecuador, Bolivia, and Spain. In *IOP Conference Series: Earth and Environmental Science* (Vol. 833, No. 1, p. 012172). IOP Publishing.

[20] Gavin, M. (2021). Abe Isoo and His 1905 US Baseball Tour: Japan's First Overseas School Excursion for a Sporting Competition. *East Asia, 38*(2), 157-179.

[21] González-Herrera, M. R., & Giralt-Escobar, S. (2021). Tourism Experiential Learning Through Academic Field Trips in Higher Education: A Case Study of Copper Canyon (Mexico). *Tourism: An International Interdisciplinary Journal, 69*(4), 471-493.

[22] Goralnik, L., Kelly, S. M., O'Connell, K., Nelson, M. P., & Schulze, M. (2021). Forest discovery: place relationships on an environmental science, arts and humanities (eSAH) field trip. *Australian Journal of Environmental Education, 37*(2), 108-119. https://doi.org/10.1017/aee.2020.28

[23] Grinfelde, I., & Veliverronena, L. (2021). Uncomfortable and worthy: the role of students' field trips to dark tourism sites in higher education. *Journal of Heritage Tourism, 16*(4), 469-480. https://doi.org/10.1080/1743873X.2020.1867560

[24] Hall, T., Healey, M., & Harrison, M. (2004). Fieldwork and disabled students: Discourses of exclusion and inclusion. *Journal of Geography in Higher Education, 28*(2), 255-280. doi:10.1080/0309826042000242495. https://doi.org/10.1080/0309826042000242495

[25] Han, I. (2020). Immersive virtual field trips in education: A mixed-methods study on elementary students' presence and perceived learning. *British Journal of Educational Technology, 51*(2), 420-435. https://doi.org/10.1111/bjet.12842

[26] Han, I. (2021). Immersive virtual field trips and elementary students' perceptions. *British Journal of Educational Technology, 52*(1), 179-195. https://doi.org/10.1111/bjet.12946

[27] Harrington, M. C., Bledsoe, Z., Jones, C., Miller, J., & Pring, T. (2021). Designing a Virtual Arboretum as an Immersive, Multimodal, Interactive, Data Visualization Virtual Field Trip. *Multimodal Technologies and Interaction, 5*(4), 18. https://doi.org/10.3390/mti5040018

[28] Holgersen, S. (2021). How to incorporate theory in (urban) field trips: the built environment as concrete abstraction. *Journal of Geography in Higher Education, 45*(3), 361-379. https://doi.org/10.1080/03098265.2020.1833317

[29] Hoover, K. S. (2021). Evaluating impacts of a wetland field trip: a case study with urban middle school students. *Applied Environmental Education & Communication, 20*(3), 203-220. https://doi.org/10.1080/1533015X.2020.1754967

[30] Humphrey, A. (2005). SWOT analysis for management consulting. *SRI alumni Newsletter, 1*, 7-8.

[31] Kemp, A., Palmer, E., & Strelan, P. (2019). A taxonomy of factors affecting attitudes towards educational technologies for use with technology acceptance models. *British Journal of Educational Technology, 50*(5), 2394-2413. https://doi.org/10.1111/bjet.12833

[32] King, M. R. N., Rothberg, S. J., Dawson, R. J., & Batmaz, F. (2016). Bridging the edtech evidence gap. *Información Tecnológica, 18*(1), 18-40.

[33] Kitchenham, B. (2004). Procedures for performing systematic reviews. Keele, UK, *Keele University, 33*(2004), 1-26.

[34] Kolb, A. Y., & Kolb, D. A. (2009). The learning way: Meta-cognitive aspects of experiential learning. *Simulation & gaming, 40*(3), 297-327. https://doi.org/10.1177/1046878108325713

[35] Kolb, B. (1984). Functions of the frontal cortex of the rat: a comparative review. *Brain research reviews, 8*(1), 65-98. https://doi.org/10.1016/0165-0173(84)90018-3

[36] Krakowka, A. R. (2012). Field trips as valuable learning experiences in geography courses. *Journal of Geography, 111*(6), 236-244. https://doi.org/10.1080/00221341.2012.707674

[37] Krantz, A., & Downey, S. (2021). Thinking About Art: The Role of Single-Visit Art Museum Field Trip Programs in Visual Arts Education. *Art Education, 74*(3), 37-42. https://doi.org/10.1080/00043125.2021.1876466

[38] Krepel, W. J., & DuVall, C. R. (1981). *Field Trips: A Guide for Planning and Conducting Educational Experiences. Analysis and Action Series*. NEA Distribution Center, The Academic Building, Saw Mill Rd., West Haven, CN 06515.

[39] Lee, W. H., Kim, C., Kim, H., Kim, H. S., & Lim, C. (2021). Students' Reactions to Virtual Geological Field Trip to Baengnyeong Island, South Korea. *ISPRS International Journal of Geo-Information, 10*(12), 799. https://doi.org/10.3390/ijgi10120799

[40] Makransky, G., Borre-Gude, S., & Mayer, R. E. (2019). Motivational and cognitive benefits of training in immersive virtual reality based on multiple assessments. *Journal of Computer Assisted Learning, 35*(6), 691-707. https://doi.org/10.1111/jcal.12375

[41] Manning, C. L. (2019, January). Teaching and Learning the Geosciences with VFTs. In *Geophysical Research Abstracts*, 21.

[42] McPherson, H., Frank, G., Pearce, R., & Hoffman, E. (2021). Virtual Field Trips. *The Science Teacher, 88*(6), 45-51.

[43] Mead, C., Buxner, S., Bruce, G., Taylor, W., Semken, S., & Anbar, A. D. (2019). Immersive, interactive VFTs promote science learning. *Journal of Geoscience Education, 67*(2), 131-142. https://doi.org/10.1080/10899995.2019.1565285

[44] Middlebrooks, M. L., & Salewski, E. (2021). Self-guided field trips take invertebrate zoology students away from their screens and into the environment for hands-on learning. *Invertebrate Biology, 140*(1), e12325. https://doi.org/10.1111/ivb.12325

[45] Mohring, K., & Brendel, N. (2021). Producing virtual reality (VR) field trips–a concept for a sense-based and mindful geographic education. *Geographica Helvetica, 76*(3), 369-380. https://doi.org/10.5194/gh-76-369-2021

[46] Moore, S. D. M., Jayme, B. D. O., & Black, J. (2021). Disaster capitalism, rampant edtech opportunism, and the advancement of online learning in the era of COVID19. *Critical Education, 12*(2), 1-24. https://doi.org/10.14288/ce.v12i2.186587

[47] Ng, D. T. K. (2022). Online aviation learning experience during the COVID-19 pandemic in Hong Kong and Mainland China. *British Journal of Educational Technology, 53*(3), 443-474. https://doi.org/10.1111/bjet.13185

[48] Nita et al. (2022). [Forthcoming]. Inclusive learning for quantum computing: supporting the aims of quantum literacy using the puzzle game Quantum Odyssey. *Research in Science & Technological Education.*

[49] Ní Drisceoil, V. (2021). Moving beyond text, embracing the visual: the Virtual Land Law Field Trip Project@ Sussex. *The Law Teacher, 55*(2), 186-197. https://doi.org/10.1080/03069400.2020.1753323

[50] Ordon, K. J., Bartelheimer, M., & Asshoff, R. (2021). Biology student teachers' interest and self-efficacy in planning and conducting field trips after participation in a university course. *Environmental Education Research, 27*(1), 88-109. https://doi.org/10.1080/13504622.2020.1849565

[51] Patiar, A., Kensbock, S., Benckendorff, P., Robinson, R., Richardson, S., Wang, Y., & Lee, A. (2021). Hospitality students' acquisition of knowledge and skills through a virtual field trip experience. *Journal of Hospitality & Tourism Education, 33*(1), 14-28. https://doi.org/10.1080/10963758.2020.1726768

[52] Peace, A. L., Gabriel, J. J., & Eyles, C. (2021). Geoscience Fieldwork in the Age of COVID-19 and Beyond: Commentary on the Development of a Virtual Geological Field Trip to Whitefish Falls, Ontario, Canada. *Geosciences, 11*(12), 489. https://doi.org/10.3390/geosciences11120489

[53] Petcovic, H.L., Stokes, A., and Caulkins, J.L., (2014), Geoscientists' perceptions of the value of undergraduate field education: *GSA Today, 24,* 4-40. doi:10.1130/GSATG196A.1

[54] Piaget, J. (1970). *Genetic Epistemology.* New York: Norton and Company.

[55] Price, Y., & de Ruiters, E. S. (2021). The virtual field trip: conditions of accessibility and configurations of care in teaching ethnography (during Covid-19). *Anthropology Southern Africa, 44*(3), 138-154. https://doi.org/10.1080/23323256.2021.2012491

[56] Pugsley, J. H., Howell, J. A., Hartley, A., Buckley, S. J., Brackenridge, R., Schofield, N., ... & Vanbiervliet, J. (2022). Virtual field trips utilizing virtual outcrop: construction, delivery and implications for the future. *Geoscience Communication, 5*(3), 227-249. https://doi.org/10.5194/gc-5-227-2022

[57] Pusca, D., & Northwood, D. O. (2021). Teaching and learning engineering design: creative methods for remote education. *World Transactions on Engineering and Technology Education, 19*(3), 306-312.

[58] Schneiderhan-Opel, J., & Bogner, F. X. (2021). Cannot See the Forest for the Trees? Comparing Learning Outcomes of a Field Trip vs. a Classroom Approach. *Forests, 12*(9), 1265.

[59] Schulze, D. G., Rahmani, S. R., Minai, J. O., Johnston, C. T., Fulk-Bringman, S. S., Scott, J. R., ... & Mashtare Jr, M. L. (2021). Virtualizing soil science field trips. *Natural Sciences Education, 50*(1), e20046. https://doi.org/10.1002/nse2.20046

[60] Soto, G. J., Kunasegar, R. S., Bing, S. B., Rahman, S. S., & Meng, C. C. (2021). An overview of workflows for developing Geological Virtual Field Trips, limitations, and future implications: A case study from Peninsular Malaysia. *Petroleum and Coal, 63*(3), 880-886. DOI:10.6084/m9.figshare.17032772.v1

[61] Sotomayor, S. (2021). Long-term benefits of field trip participation: Young tourism management professionals share their stories. *Journal of Hospitality, Leisure, Sport & Tourism Education, 29,* 100285. https://doi.org/10.1016/j.jhlste.2020.100285

[62] Tigert, J. M., Fotouhi, G., & Kirschbaum, S. (2021). An investigation of museum educators' questioning during field trips. *Learning, Culture and Social Interaction, 31*, 100571. https://doi.org/10.1016/j.lcsi.2021.100571

[63] Trinh, E. (2021). What does social justice look like in the United States? Critical reflections of an English language classroom on a field trip. *Multicultural Perspectives, 23*(2), 108-113. https://doi.org/10.1080/15210960.2021.1914046

[64] UNESCO (2017). *Education for Sustainable Development Goals: Learning objectives.* Paris: UNESCO.

[65] Vygotsky, L. S. (1978). Socio-cultural theory. *Mind in society, 6*, 52-58.

[66] Welsh, K. E., Mauchline, A. L., Park, J. R., Whalley, W. B., & France, D. (2013). Enhancing fieldwork learning with technology: practitioner's perspectives. *Journal of Geography in Higher Education, 37(*3), 399-415. https://doi.org/10.1080/03098265.2013.792042

[67] Wolf, M., Wehking, F., Montag, M., & Söbke, H. (2021). 360°-Based Virtual Field Trips to Waterworks in Higher Education. *Computers, 10*(9), 118. https://doi.org/10.3390/computers10090118

[68] Yacobson, E., Fuhrman, O., Hershkovitz, S., & Alexandron, G. (2021). De-identification is Insufficient to Protect Student Privacy, or–What Can a Field Trip Reveal?. *Journal of Learning Analytics, 8*(2), 83-92. https://doi.org/10.18608/jla.2021.7353

[69] Zhao, J., Wallgrün, J. O., Sajjadi, P., LaFemina, P., Lim, K. Y., Springer, J. P., & Klippel, A. (2021). Longitudinal effects in the effectiveness of educational virtual field trips. *Journal of Educational Computing Research, 60*(4), 1008-1034. https://doi.org/10.1177/073563312110629

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