Notes on Distance Learning for Informal Settings

White Paper #1: Definitions and History

July 31, 2023

Prepared by:
Joe E. Heimlich, Ph.D.
Gary Timko, Ph.D.
Donnelley Hayde, M.A.

Prepared for:
Indiana University

Overview

This literature review is funded in part by a grant from the National Science Foundation #1713567 and prepared for Indiana University as part of a larger project entitled *Data Visualization Literacy: Research and Tools that Advance Public Understanding of Scientific Data* (Dr. Katy Börner, Principal Investigator). This white paper is one component of a larger review. The larger review consists of three white papers, the first of which explores definitions, the history of distance education, and the technologies used for distance education over time. The second white paper explores the best practice considerations most widely employed in distance education. The third document focuses on the use of and strategies for applied evaluation of distance education programs. Together, the series of white papers aims to identify key elements of distance education across contexts, as well as the transferability of these approaches to informal science learning institutions.

Introduction

In a 2003 interview with *The American Journal of Distance Education,* Michael G. Moore (2003), editor of the *Handbook of Distance Education,* said: "I believe quite passionately that the current exuberance for practicing distance education in the dark, uninformed by theory and research, is tragic, particularly from the point of view of the students who are being served up with programs that fall far short of what informed people should be able to deliver, but also for administrators and policymakers who have put far too much faith in new communications technologies and missed the point that good-quality distance education requires changes in organizational structures and pedagogical methods" (p.73).

The rapid move to distance education by science centers and other informal education organizations demanded by the pandemic of 2020 pushed institutions to expand existing distance education practices and implement new ones. Online groups such as the Visitor Studies Association's (VSA) listserv and the Zoo and Aquarium Focused Interest Group (ZAFIG) of VSA on Facebook were inundated with questions about practice and evaluation, and requests for 'what works' were rampant. While informal and nonformal education institutions and organizations are perhaps better poised to integrate pedagogical and andragogical methods more in line with the technology than lecture adaptation, which may seem an easy transfer but prove to be a less effective approach as will be discussed both below and in the second white paper), there are still questions from skilled educators and evaluators about the arena of distance education and distance learning. The formal education sector, which has been the dominant player in distance education, has commonly lacked access to and training in what has been learned from preceding studies of distance education (e.g., Simonson, 2001 cited in Simonson et al., 2019). The issue of research to practice is common in many fields (cf. Bansal et al., 2012; Broekkamp & van Hout-Wolters (2007); Korthagen, 2007; Vanderlinde & van Braak, 2013). Black (2004, p.6) called

this out saying "when distance educators assume they are studying or practicing a new field without a history, important pre-established foundational values and ideas, knowledge and experiences, and 'lessons learned' are lost."

This first white paper in the series is a scan and synthesis of the literature looking for patterns and cumulative insights into what has been learned over the history of teaching and learning from a distance. In part, it focuses on what has been learned related to pedagogy, andragogy, and design for learning in a distance construct. Similarly, it explores what evaluation practices best facilitate data for program improvement and are appropriate for determining efficacy of the teaching on behalf of the organization and the learner.

Method

In conducting this review, the authors began by exploring the literature in numerous books, databases, journals, websites, and bibliographic resources specific to distance education. The authors approached this review by first reading some of the documents from these sources on distance education that focused on practices. The authors noted the key terms used for distance education stages/eras/technologies, who authored specific chapters, and key findings, conclusions, or implications offered with citations. Next, the authors conducted a systematic search of the journals specifically related to distance education that included the Review of Educational Research, International Journal of Distance Education, American Journal of Distance Education, and Educational Technology & Society.

The authors advanced the search strategy using a circular search strategy (Heimlich et al.,1999) via the Google Scholar website using terms that included: distance education, on-line education, web-based instruction, practices in virtual education programs, presence in distance education, distance learning, synchronous instruction, asynchronous instruction, and on-line learning and used a circular search strategy to explore the articles that emerged to identify differences or new information, and the citations were explored to compare against the list of citations we built from the initial search. Using these terms, the authors continued to expand the search until we were not discovering any significant, new information and we were seeing the same authors and articles cited (closing the circle).

The review was not intended to be a critical literature review, but a broad sweep and synthesis of what is generally agreed to in the literature about the definitions of and the history/technologies for distance education. As the focus of this white paper review was history and technologies, we did not bound the search within any time frames.

Defining distance education

Distance education is a generic, umbrella term (Bates, 2005). It includes all the various forms of study at all levels which are not under the continuous, immediate supervision of educators present with learners (Mielke, 1999). Distance education implies consistent non-contiguous communication between the organizer/educator and the learner which historically involved two kinds of communication: 1) one-way in which materials sent involve the learners in interaction with texts (also called simulated communication); and 2) two-way which involves direct communication between learners and the organization/educator, which Holmberg (1989) called the 'real' communication. A critical definition offered by Rumble (1989) stated "In any distance education process there must be: a teacher; one or more students; a course or curriculum that the teacher is capable of teaching and the student is trying to learn; and a contract, implicit or explicit, between the student and the teacher or the institution employing the teacher, which acknowledges their respective teaching-learning roles" (p.18).

Two components are present in all discussions and definitions of distance education: 1) the physical distance and 2) the medium or delivery method. Simonson (1999) defined distance education as "separation of teacher and learner, the influence of an educational organization, the use of media to unite teacher and learner, the necessity for two-way communication, and the potential for individualized learning" (p.5). This is the definition also used by the Association for Educational Communications and Technology (www.aect.org) and very much in alignment with the work of the Instructional Technology Council (www.itcnetwork.org), both of which are focused exclusively on formal educational use of distance education. Other terms entered the lexicon including e-learning, technology-mediated learning, mobile learning, online collaborative learning, virtual learning, web-based learning etc. (Kanuka & Conrad 2003). Moore et al (2011) identified the commonalities across definitions as 1) some form of instruction occurs between two parties, 2) it is held at different times and/or places, and 3) uses various forms of instructional materials. They recommended moving the definitions focused on the technology back under a larger umbrella.

Keegan (1988) included many of the above concepts in five components to define distance education:

> 1) a quasi-permanent separation of teacher and learner throughout the learning process,
> 2) the influence of an educational organization in both planning and preparation of learning materials, and in provision of student support services,
> 3) use of technical media: (print, audio, video, or computer) to unite teacher and learner and convey the content,
> 4) the provision of two-way communication so that the learner may benefit from or even initiate dialogue, and

5) the quasi-permanent absence of the learning group throughout the learning process so that people are usually taught as individuals and not in groups.

While distance learning and distance education are closely related, they are not the same. Education is a systems process involving management and components such as content sources, program/course design, delivery, interaction, and the learning environment (e.g. Mehrotra et al., 2001; Moore, 1993; Moore & Kearsley, 2012; Verduin & Clark 1991). Learning is an internal process held by the individual learner.

There are many other terms used to describe the concept of learners and educators interacting over either physical distances, or as is suggested with the newer technologies, more likely psychological distances (e.g. Bates, 2005; Black, 2004; Moore, 1991, Saba, 2005). Box 1 provides a partial list of the labels the authors of this white paper found that are used in academic literature. Some terms used to discuss distance education are closely related and are sometimes used as synonyms or as interchangeable, though there are differences between and among them. As one example, open learning is considered to be a goal or an educational policy of removing barriers to learning and must therefore be open or accessible for everyone, which demands the educational program be scalable so that it can meet large growth (Bates, 2005; also see Bozkurt, 2019 for an extensive discussion on definitions of distance education and open and distance learning). The broader terms distance education or distance learning cover the various forms of study at all levels that are not under the continuous, immediate supervision of educators present with the learner(s). One study (Moore, et al., 2011) examined e-learning, online learning and distance learning environments and, to be able to compare the studies, needed to explore how the different studies defined the terms. This study found six clusters of ways the terminology differs: no difference, organized by a hierarchy created by the author, defined by media type, defined by access type, defined by correspondence, and defined by interaction.

> **BOX 1: SOME LABELS FROM THE LITERATURE**
>
> Correspondence education
> Distance learning
> Distance teaching
> Extension study
> External learning
> External study
> Flexible education
> Flexible learning
> Independent study
> Independent learning
> Individualized learning
> Life-long education
> Non-traditional education
> Open learning
> Open teaching
> Resource-based learning
> Self-access learning
> Self-study
> Supported self-study
> Teacher absent
> Teaching at a distance
> Telemathic teaching

In a challenge to the field, Phipps & Merisotis (1999) acknowledged while it is important to understand what is meant by distance learning, as technology evolves, the definition continues to change. While noting that Phipps and Merisotis used the terms distance education and distance learning as interchangeable, King et al. (2001) argued the profession should instead strive for collaborative dialogue and a shared

science. They explained that significant, research-driven progress can only be made when definitions are semantically, as well as operationally, consistent within and across articles. King et al. (2001) ultimately offer the definition, "distance learning is improved capabilities in knowledge and/or behaviors as a result of mediated experiences that are constrained by time and/or distance such that the learner does not share the same situation with what is being learned" (p. 10).

In this scan and synthesis of the literature, we are using the terms each of the authors use with fidelity to their individual definitions. For our broader statements, we use the labels *distance learning* to refer to outcomes in the learners, and *distance education* to refer to the inputs by the educator or organization. Further, an important limitation is that this review is focusing on the historical foundations primarily in the U.S. and the more contemporary literature primarily in English-language journals and resources.

History and phases

Distance education emerged from a need for study alongside paid work, for individual versus group learning, and to reach adult students not in urban centers (Holmberg, 1995). Distance education started as an adult education approach that allowed greater access to learning across more populations than historically had been possible (Holmberg, 1995a). Distance education's history is closely tied to the development of technology (Kentnor, 2015) as available technologies provide the modes of delivery of the content (Lease & Brown, 2009). While original dates and incidents vary in different reports, there is evidence from the early 1700s into the 1800s of correspondence courses (e.g. Bozkurt, 2019; Mehrotra, 2001; Pittman, 2003).

The emergence of distance education as a movement, however, did not occur until the construction of the railroads allowed for the postal service to provide a more expedient distribution of the content. This initial dependence on a particular innovation in technology to allow for the educational enterprise to grow foreshadowed the shift in technologies useful for distance education that sped up rapidly in the last half of the 20th century and through to the present (cf. Bates, 2005; Pittman, 2003; Sumner, 2000). Banas and Emory (1998) noted just before the turn of the current century, "new trends and products that change the fabric of distance learning and training emerge continually" (p. 369). Over time, six factors emerged that help determine the acceptance of a technology, especially for use in distance education: simplicity, trialability, observability, relative advantage, compatibility, and support (Wilson et al., 2002). While developments in technology created the narrative of distance education, it is useful, however, to consider the suggestion from Tosti & Ball (1969) to distinguish a presentation from the media. They noted, "A student does not learn from the media. He [sic] learns from the presentation form. Media do little more than deliver the information to be learned in whatever presentational form previously decided upon" (pp. 9-10).

The term "media" has been a confounding element in discussion of distance learning: Bretz (1971) defined medium being "something in the middle, between other things and most often it is considered as a vehicle or instrument for making something happen" (p. 5). He makes a distinction between teaching aids supporting a presentation, and media which are self-supporting. In a later work conducted for the U.S. Air Force, Bretz (1972) created both a process (Method of Designing Instructional Alternative) and a taxonomy of media with eight classes: 1) audio-motion-visual, 2) audio-still-visual, 3) audio-semi-motion, 4) motion-visual, 5) still-visual, 6) semi-motion, 7) audio, 8) and print. This work was important as it laid clear that a medium makes demands on the instructor and the message construction. Many taxonomies are offered in the literature of instructional technology, each attempting to define or refine how media are selected and used. A sample of these include:

- Meredith (1965) looked at the psychophysical operations of media, included the physical, neuro-anatomical, and ecological variables that affect learning from each medium,
- Clark (1975) who examined prior taxonomies and suggested a conceptual model of a cube with the three dimensions of media attributes, subjects/learners, and behaviors,
- Heller & Martin (1995) whose taxonomy used four types of media crossed with the expression of each medium in terms of elaboration, representation, and abstraction, and
- Fresen's (2007) taxonomy of factors to promote quality web-supported learning.

Across these taxonomies, what emerges is the common understanding that media have the capabilities to influence learning for particular learners, tasks, and situations (Kozma, 1994). For this review, we are less concerned about any specific type of instructional medium, and rather focus across the media used for distance education and lessons learned from studies that are transferrable to informal learning contexts.

For over 100 years, academics have been studying how people learn when the learner is distanced from the educator. There have been syntheses of prior research such as Holmburg (1987, 1989), Verduin & Clark (1991), Harper et al., (2004), and Wong (2007), which all reveal a wide swath of programs under the umbrella of distance education. Scholars have generally presented the history of distance education in phases or stages. The differences in how they parse the phases is determined by how each views the changes to distance education due to innovations in technology (See Table 1). There is widespread agreement that correspondence courses gave way to radio, but even during the early years of correspondence courses, there were universities providing pressed recordings of lectures as part of their courses in the early 1900s (Passerini & Granger, 2000). We also note that while transitions were uneven in how they emerged, many of the tools of distance education from the past are used in distance education currently (e.g. correspondence courses, radio, broadcast and educational television, and satellite). Throughout the history of distance education, research done in the field suggests that while the media vary, it is still individual people on the receiving end, and many of the characteristics of

human learning do not change via distance. Knowing the particular audience and individuals in the learning group is central to success (Moore & Kearsley, 2012).

Table 1:   Examples of Phases in Distance Education

Phase	Bozkurt (2019)	Passerini & Granger (2000)	Demiray & İşman (2003)	Harper et al., (2004) Taylor (2001)
1	Correspondence distance education	Print - Correspondence courses	Pre-correspondence education	1600-1900 -Use of mail to deliver material
2	Visual-Auditory	Radio	Heavily applied correspondence education systems	1920-1926 - Correspondence education/use of radio and television
3	ICT-Based	Broadcast	Instructional radio and television	1970-1980 – pre-recorded video and cassette recordings; limited broadcast
4		Computer	Two-way audio and video interactive	1980-1990 – teleconferencing

Taylor: flexible learning online |
| 5 | | | Satellite, computer and integrative systems | 1990-2004 – dominance of web; wireless technology

Taylor – "intelligent" digital technologies |

The technologies of distance education

As the literature continually reminds us, distance education developed in alignment with the development of technologies: trains and correspondence schools emerged in concert as the postal service was able to deliver mail at a longer distance in dramatically less time; broadcast radio allowed for reaching larger audiences or more geographically spread people in real time. Technology has played an instrumental role in the historical progression of distance education, and as technology continues to improve and evolve, so too will the field of distance education continue to provide

new learning opportunities to learners (Bozkurt, 2009). The history of distance education is predicated on the technologies available over time.

Although presented below as a linear process, the continued development of distance education is a story of ongoing accumulation and integration of new tools and delivery systems. One clear understanding that emerges in looking across the history of distance education is that technologies tended to accumulate and adapt to create a field that was dynamic and fluid in terms of expanding tools (e.g.Bates, 2005; Mehrotra, et al., 2001; Sumner, 2000). For example, the early recordings of lectures at the University of Wisconsin (Wisher & Curnow, 2003) and the use of phonograph recordings to accompany correspondence in the early 20th century (Holmberg, 1995) logically fed into the use of radio, and lessons from radio helped transition in the broadcast use of educational television. The development of more ubiquitous recorders and players allowed for cassette tapes leading to videocassettes, then CDs, DVDs, and blu-ray, satellite and dial-up to fiber optic cable, wireless computer, and beyond.

Inglis, Ling & Joosten (cited in Inglis, 2003) identified a major difference between distance education programs as whether the program adopted a classroom-based or a resource-based delivery model. The classroom-based approach assumes a learning model relying on dialogic interaction between the student and teacher and/or student to student, while resource-based learning occurs through interaction between the student and self-paced instructional materials. This difference again reveals a determination that leads to different ways the learning materials are used, and therefore how they are constructed. As one example, although many consider broadcast radio and television to be more or less identical with audio and video recordings, this is highly inaccurate (Holmberg, 1995). Unlike the recordings, the broadcasts are ephemeral, cannot be reviewed, are uninterruptable, and are presented at the same pace for all learners (Bates cited in Holmberg, 1995a).

Correspondence courses

Different scholars use different events and dates for marking the start of correspondence courses, with some noting the first record of correspondence study as a 1728 posting in the *Boston Gazette* advertising weekly shorthand lessons (e.g., Bower & Hardy, 2004; Holmberg, 1995a) or the 1833 study of composition offered through an advertisement in a Swedish newspaper (Pant, 2014). Others use the first university that offered a course, on the study of composition, in Sweden in 1833 (e.g., Holmberg, 1995), followed a few years later in England by a postcard-based course on shorthand, which later became the Sir Isaac Pitman Correspondence Colleges (Holmberg, 1995a). But it was the postal system and the emergence of the railroad system in the U.S., as previously described, that enabled distance education to be viable (Casey, 2008; Sewart, 1993). By the late nineteenth century, correspondence courses had spread widely. The first university to offer a major distance education college program was likely the University of Chicago in the late 1800s (Lease & Brown,

2009; McIsaac & Gunawardena, 1996). Since the initiation of correspondence courses — sometimes called home study by for-profit schools and independent study by universities (Bozkurt, 2019) — there is a well-documented history involving universities, newspapers, religious institutions, and secondary schools providing educational opportunities via correspondence designed either to allow each learner to progress at their own pace through the program or to follow a more rigid schedule of lessons (e.g. weekly) (Simonson, et al., 2019). The proliferation of correspondence courses in the late 1800s and early 1900s led to a rapid growth of correspondence schools, which in turn led to "concerns about the quality of instruction and questionable and possibly unethical practices" (cf. Lease & Brown, 2009, p.416). By the 1920s, correspondence schools in the U.S. had such a bad reputation that a movement for creating standards arose and led to the formation of the National Home Study Council, eventually renamed the Distance Education and Training Council, and now known as the Distance Education Accrediting Commission (DEAC, 2021). It is the role of the DEAC to accredit any postsecondary institutions that offer programs primarily by distance education from non-degree up to and including the professional doctoral degree.

The original audiences for correspondence courses were adults with occupational, social, and family commitments that limited their ability to attend courses. The learners were mostly adults traditionally excluded from continuing formal education such as workers, farmers, women, and specifically young women of leisure class who were able to enhance their education even while confined to their homes due to the conventions of the era (Harting & Erthal, 2005). The latter is exemplified by the creation of the Boston-based Society to Encourage Study at Home, founded by Anna Eliot Ticknor in 1873. The focus of this society was on providing housebound women with over 20 courses in various subjects (Simonson, et al., 2000). This "silent university" became a network of women teaching women by mail (Bergmann, 2001).

Even with the railroad, mail was often slow, and the need for more facility in communication fueled the journey for these early print correspondence courses to morph into what would eventually become known as distance education.

Radio

With the development of radio and later, television, the potential for wide distribution of courses and programs quickly became possible (e.g., Bozkurt, 2019; Clark, 2003; Hanna, 2003). The ability to have live educational shows reduced delivery time and increased classroom immediacy through the audio connection (Casey, 2008). By the 1920s, there were at least 176 radio stations at universities. Though most were gone by the end of decade, those remaining were generally at land-grant colleges. Many universities did not take advantage of the medium appropriately, and some academics suggest the programs were unsuccessful as among other reasons, people found the programs boring, there was minimal interest in faculty to deliver instruction via radio, and there was minimal public recognition for the need for courses delivered by radio (Buck, 2006).

Radio served a variety of educational purposes, one of which was for land-grant university extension programs (Saba, 2005). The University of Iowa offered the first radio course in 1934 (Casey, 2008), and by 1941, university extension courses were offered for credit (Moore, 2003). The Canadian Broadcast Corporation was a leader in the use of radio technology for distance education starting in the 1920s using mailed kits that were connected to radio programming (Buck, 2006). The use of radio was enhanced following WWII with the German technology for automated radio stations that operated without personnel. This allowed for educational materials to be produced in small segments and later assembled into the proper sequence. The improved quality of audio-taped recordings led to using audio tapes to supplement correspondence courses. (Lease & Brown, 2009).

Radio had an important role in the progression of distance education and does still have a presence. There was early use of two-way radio in medical education with a high-powered transmitter at the medical college transmitting to the residency hospitals, and the hospitals with more limited-powered transmitters responding (Woolsey, 1958). In North America, radio continues to be used in distance education and informal learning programs in Canada, and some programs for National Public Radio in the U.S. are used for informal learning programs. Radio also continues to be an important tool for distance education in countries in Asia and Africa (Berman, 2008).

Audio-visual distance education

Video-based instruction has been widely used in distance education since the early days of black-and-white educational films. Starting in 1902 (Wisher & Curnow, 2004), educational films were able to reveal things not visible to the naked eye in real-time, such as slow and time-lapse motion of natural phenomena, microscopic examinations, and underwater views of marine life. The integration of audio with video was foundational to the use of video for learning from the early black-and-white films through to the present (Holmberg, 1995; Wisher & Curnow, 2004).

In the1930s, broadcasters experimented with educational television, and programs for K-12 classes were implemented through the University of Iowa in 1933. These programs expanded to include supplemental 15-minute evening broadcasts to youth groups, such as scouts working on merit badges (Clark, 2003). By the 1950s, educational television courses were offered for credit by higher education institutions and expanded with the emergence of closed-circuit television as a tool for teaching (Simonson et al., 2000). It was during this time television emerged as a tool to support correspondence study (Black, 2004).

The FCC created the Instructional Television Fixed Service in 1963 which provided 20 television channels available only to educational institutions as a low-cost way to offer a subscriber-based system for broadcast courses (Casey, 2008), allowing for dedicated educational access television. Over the decades, educational television has been shown to influence viewers' attitudes, behaviors, knowledge, and skills (Moeller, 1996).

Broadcast television relies on the passive nature of the viewer. Educational programs via broadcast often take the form of documentaries, dramatizations, and instructional programs. Broadcast educational television has been around since the 1960s (Bates, 2005) and originally presented information that was transient and ephemeral, presented continuously, and retrievable only from memory (Moeller, 1996). With the advent of being able to capture video during broadcast, the retrievability aspect of programs shifted, but the structure of the programs remained primarily didactic. The presentation of the information as commercial television focuses on what occurs in the studio, and the viewer is considered just that, a viewer (Ljoså, 1992; Moore & Kearsley, 2012). Broadcast television can provide programs designed for broadcast that are about cognitive or affective development, whether it is the well-studied impacts of productions such as Sesame Street, Mr. Rogers' Neighborhood, and Blue's Clues, or the value of a cooking show or historical narrative. Further, there is value in television as a tool for information and education campaigns for large audiences (Ljoså, 1992).

Educational television, as a specific label, usually refers to programming, sometimes for broadcast, that is curricular in design and has intended outcomes tied to a curriculum. Over decades, this type of programming reveals both short- and long-term benefits to children (Anderson, 1998) as demonstrated by the well-studied Sesame Street (Moeller, 1996). Unlike commercial television, what is important for educational television is not what is on the screen as much as how the person watching the screen is engaging with the content being shared; distance education "can only succeed when the remote learner is at the center of everything" (Ostendorf, 1997, p.52). For educational television, the context of learning is an important consideration for effectiveness (Wisher & Curnow, 2004), e.g., home rather than a classroom, an individual learner versus a group of learners in one place, at one's workplace or a community center. Also, as a tool for learning, television (and the broader audio-visual platforms) carries with it a very different relationship with the learner. Television is generally seen and used by people as a passive activity (Moeller, 1996). Salomon (1984) studied the Amount of Investment of Mental Effort (AIME) in learning with the assumption that investment would relate to outcome. In a study comparing print and television, he used a silent film for half the students and text of a comparable story or narrative with the other half. The children felt greater efficacy with the television and perceived it as easy and realistic. The reality, however, was the print demanded more effort but led to better inference-making. Efficacy correlated positively with AIME in print and negatively in television.

Television as used in distance education is a broad term that captures a wide array of distribution methods including one- and two-way video systems, one-way video teaching by satellite sometimes called business television, and satellite and cable (Black, 2004; Saba, 2005; Shearer, 2003). The early use of film which moved to videocassettes continued to morph through emergent technologies for both capture and play including CD-ROMs and DVDs (Lease & Brown, 2009). From broadcast and cable television, additional means of transmitting the audio-visual 'package' included

microwave, fiber optics, and audio graphics as tools for distance education (Mielke, 1999).

Bretz (1972) found that while television as an instructional system can have qualitative advantages, as a medium it does not result in any greater scholastic achievement than classroom presentation. Studies through to the present continue to document cases where television sometimes does better, sometimes worse, and sometimes about the same as in-person education, though most of these studies are of courses (or as in Sesame Street, curriculum).

Educational television does serve a variety of functions: a program can represent a self-contained curriculum that does not require any additional materials or structured learning experiences. It can also serve as one of many learning materials that relate to certain aspects of a given curriculum (Moeller, 1996). Prior to e-Learning, Ostendorf (1997) wrote, "television teaching is the most popular distance learning medium today. Instructors experienced in the traditional classroom face significant challenges when entering this new teaching environment" (p. 51).

Within the history of educational television is the emergence of the open universities and distance universities that started forming around 1970 and offered multi-media distance education, especially grounded in radio and television (Clark, 2003). Some of these organizations grew into mega-universities of over 100,000 students (Anderson & Simpson, 2012; Bozkurt, 2019; Daniel, 1998).

With access to satellite distribution emerging more strongly through the 1980s, opportunities for educational television continued to expand as did the potential to reach more dispersed and remote audiences (Simonson et al., 2019). Although initial attempts using satellites were criticized for being poorly planned, programming improved over time (Simonson et al., 2019) and it was during this period that theoretical research on learning via distance really began (cf. Moore & Anderson, 2003).

Telephone

Use of the telephone for teaching goes back to the 1930s and 1940s but wider use for distance education emerged in the 1960s and grew through the 1970s and into the 1980s (e.g. Hentea et al., 2003; Olgren, 1997; Puzzoli, 1970). The telephone is used in several different ways in distance education. For example, Flinck (1975) makes a distinction between teleteaching, tele-lecturing, and tele-tutoring:
- teleteaching involves having a phone in the classroom so a student could keep up with classwork while being absent;
- in tele-lecturing a teacher can give a lecture to one or several groups of students; dial access is an information service that provides a caller with a recorded summary/narrative (this had been widely used in libraries for homework responses); and

- tele-tutoring allows a student to have individualized help in their studies.

In formal education, telephone instruction was initially used for meeting the needs of homebound and hospitalized students (Hershey, 1977). In a study of a group of homebound students in which a telephone was one of the tools used for their coursework, Lolis (1968) describes two different models of use of tele-classes: the first was a model used in California in which a group of pupils were taught completely by tele-class and included group participation, peer interaction, recitation, and discussion opportunities. The second was a model in New York state using the telephone as a follow-up to a radio broadcast lesson by means of a group tele-class conducted by the broadcast teacher.

For decades, the telephone was used in some distance education courses as a means of direct tutoring at a distance (Holmberg, 1995a). Later, with improvements in teleconferencing systems, the voice-only technology was able to link multiple sites that can be widely distanced from each other (Olgren, 1997). This facilitated more interaction among the learners and led to the tele-lecture with the goal of bringing individuals and/or groups together in one of three models: 1) an external speaker presenting to a single group, 2) an external speaker presenting to several groups in a number of sites, or 3) interaction of a number of speakers/audiences at a number of different sites (Puzzuoli, 1970).

The use of telephone in distance education grew greatly in the late 1980s and 1990s with the development of teleconferencing technologies using a simple telephone amplifier and telephone service (Lease & Brown, 2009). Audio-conferencing or interactive audio provided a relatively inexpensive method of instructional delivery (e.g. Bates, 2005; Simonson et al., 2019; Taylor, 2001). Later, the telephone had an important role in the early use of personal computers for distance courses. Compressed video allowed the existing copper telephone lines be used for transmission, making the telephone system a component of the delivery mechanism for getting content to the learner (Mehrotra et al., 2001).

e-Learning

While e-Learning is generally accepted as learning that takes place in an electronically simulated environment, the 'e' "could also represent, *evolving, enhanced, extended, everywhere, everytime, and everybody*" (Li & Masters, 2009, p. 246). The dominant contemporary idea of distance education in the U.S. is primarily based in the personal computer and the digital learning environment, networks, off-line and on-line databases, and the hardware and software for video conferences, virtual seminars, co-operative learning and working (Moore et al., 2010; Simonson et al., 2019). In a review of the literature on e-Learning, Moore et al, (2010) found some authors explicitly defined e-Learning, while others implied a specific definition or view of e-Learning in their articles. The definitions range from web-based instruction, content and instructional methods delivered on a computer (including CD-ROM, internet, intranet), use of information and communication technologies to support

learning, and a wide set of applications and processes such as web-based learning, computer-based learning, virtual classrooms, and digital collaboration.

The development of fiber-optic communication systems allowed for significant expansion of live, two-way, high-quality audio and video systems in education (Mehrotra et al., 2001; Simonson et al., 2019) and the high-speed broadband transmission system allowed distance learning using the internet to become the next era of distance education (Casey, 2008). A major benefit of these changes focused on enhanced video capability. Historically, video programs had been limited to a linear continuity, but the computer allowed for interactive video with fast access to video images to be integrated into the educational program in different ways, and the streaming capabilities of video allowed for on-demand access (Wisher & Curnow, 2004). This shift was the beginning of the digital-knowledge age and the networked society, where new learning models appeared with highly rich and interactive content with multimedia and hypermedia. The shift facilitated learning through doing through learner-controlled interactive technologies (Dede, 1996). In these systems, the "scope of the concept of 'distance' was altered, as distance in time and space had lost importance" (Bozkurt, 2019, p.258).

During the 1990s and early 2000s, many online educational programs started and many of these programs did not survive. Of these failures, a large proportion of them were online programs begun by traditional brick-and-mortar institutions. While many factors influenced the decline of online programs in these institutions, the most significant were the lack of understanding of online pedagogy and online learning styles, as well as the lack of faculty buy-in for online education (Marcus, 2004). With additional time, improved technologies, and continued study, e-learning is now better understood, and is a part of most formal education systems in various forms (cf. Bates & Picard, 2005 and Simonson et al., 2019).

Holmberg (1995) refers to three forms of communication via computer conferencing systems (CCS): 1) dialogue or one-to-one communication (email); 2) one-to-many communication using electronic bulletin boards; and 3) group discussion (many-to-many) communication using electronic meeting functions, which Ljoså (1992) called the essential element of the CCS. Sharples (2000) considered the potential for technology-mediated lifelong learning for individuals and framed five approaches for use of technology in learning:
1. Computer as a substitute for the educator;
2. Computer-based assistance through tools such as simulations and modeling;
3. Organize knowledge within a conceptual framework and provide tools such as dictionaries, topic and concept maps, learning organizers, planners, etc.;
4. The technology mediates the communications actively supporting learners through such mediation as personalization to the ability or level of the learner; and
5. Computer-based learning environments such as simulated labs, virtual worlds that mirror real locations, and online classrooms.

It should be noted that broadly through the literature, the importance of e-learning was generally seen as a necessary economic model for universities and the business sector (Bates, 2005; Cannell, 1999; Simonson et al., 2019). This set of reviews was conducted following what had been a mandatory shift to online engagement for work, school, conferences, and even socializing. Thus, increased attention to online engagement by museums and other informal and nonformal as well as formal educational institutions became a necessity. The important shift to thinking more holistically about integrated educational programming provides a marker for rethinking the roles of educational institutions of all sorts in their communities. This mirrors the calls in the literature for moving from e-Learning as an instructional paradigm to a learning paradigm and for distance education to begin to critically explore theoretical underpinnings of teaching and learning in distance education (e.g., Cannell, 1999; Moore, 2003).

For both e-learning and m-learning (following), there are some necessary cautions. Bates (2005) reminds us that decisions still must be made under what circumstances e-learning or m-learning will be appropriate, and whether older technologies such as print or broadcasting might offer other advantages (Chapter 2, p 1, e-book). There are many assumptions of access that are true for most of the population but are not true for all. Because of the general accessibility to technology, it is easy to overlook those who do not have either connectivity (or else for whom it is very slow and unstable) such as in rural areas which has been an ongoing issue both in the U.S. (cf: Malone, 2001; Whitacre & Mills, 2010; Horrigan, 2014; Freeman et al., 2022) and in other countries (e.g. Talebian, et al., 2014; Esteban-Navarro et al., 2020). Similarly, not all people have access to recent smart phones or tablets and the use cases may vary dramatically as for students with disabilities (Thomas et al., 2019) and so caution is urged in considering the desired reach and accessibility and conditions of accessibility before determining a platform to use.

m-Learning

M-learning, or mobile learning, refers to the use of mobile devices including wireless, portable, and handheld devices in teaching and learning (Hayes et al., 2004; Kumar, 2013; Traxler, 2015). An extension of e-learning, m-learning, draws on theory and practice of pedagogies used in technology-enhanced learning (Traxler, 2007). Repeating the claims of earlier changes in distance education technology, m-learning is about making it easier to affect the learning that happens at a distance. Wireless data communication via short message service (SMS) and wireless access protocols (WAP) offer great potential for incorporation into wireless and handheld computing distance learning (Motiwalla, 2007). As any learning technology emerges and evolves, there is ongoing debate as to whether it is a next step from the prior technology or simply an advanced tool that integrates with the prior technology, in this case is m-learning the next step *from* e-learning, or a new tool to integrate with e-learning (Caudill, 2007).

Traxler (2007, p. 4) compared words used in the literature to describe both e-learning and m-learning and found the descriptions of m-learning benefits used words such as "'personal', 'spontaneous,' opportunistic,' 'informal,' 'pervasive, ''situated,' 'private,' 'context aware,' 'bite-sized,' and 'portable.'" This is contrasted with words from the literature of conventional *tethered* e-Learning such as "'structured,' 'media-rich,' 'broadband,' 'interactive,' 'intelligent,' and 'usable'." Traxler (2005, p.264) also added emerging terms such as 'connected,' 'personalized,' and 'interactive.' Sharples (2000) classified m-learning tools as highly portable, individual, unobtrusive, available, adaptable, persistent, useful, and intuitive.

Mobile technology allows distance learning to be truly portable and accessible at any time (Parsons & Ryu, 2006). Further, this technology is convenient as the devices are easy to use, cost-effective, and efficient (Abas et al., 2009). Additionally, the technology allows for different scales of distance such as remote and widely distanced learners including very rural areas (Kumar, 2013), and also for administrative and academic support (Caudill, 2007). One caution offered is that different hardware and software platforms support rather different interpretations of mobile learning (Traxler, 2007).

In using the mobile for teaching, the learning scenario is not determined by the use of a computer but allows interactive digital media to be a 'resource-at-hand' in the background, which can be made analogous to traditional paper and pencil (Pinkwart et al., 2003). There is potential for educators to use the technology for 'just in time' or 'fast learning' that is specifically targeted to the user's current context and learning needs (Tetard et al., 2008). The SMS function in the handhelds has a special role in m-learning as it can be used both as a push mechanism to communicate out about studies, reminders, and short assignments, and also as a push/pull tool with the educator pushing out content and learners replying with questions or requests for assistance (Abas et al., 2009). Motiwalla (2007) offered a framework for determining m-learning applications for both push and pull mechanisms and personalized and collaborative content to identify appropriate uses of the available tools in distance education.

An important understanding from e-learning is the important implications emerging from aspects of separation and transactional distance. Depending on whether the learners are on a campus, transnational, in the home, the workplace, fieldwork locations or other places made possible by the mobile learning technologies (Benson & Samarawickrema, 2009), the context in which the learner is physically present is a component of the teaching/learning exchange.

Advantages of m-Learning can be summarized as being advantages of access—time, place, or convenience (Caudill, 2007; Denk, 2007). M-learning benefits from the mobility of the technology and that the supporting platforms are ubiquitous, convenient, localizable, and can be personalized (Parsons & Ryu, 2006; Sarrab, et al., 2013). The technology is not only highly portable, but also unobtrusive (Sharples, 2000).

As with any tool for teaching, the success in the application of m-learning depends on 1) the place and time, 2) the learner, 3) the subject matter to be learned, and 4) the skills to be applied (Tetard et al., 2008). Yousafzai et al., (2016) note that educational content delivered on mobile devices presents both pedagogical and technical issues. They offer a taxonomy of five areas of technical issues including mobile device issues, networking issues, content heterogeneity issues, delivery issues, and user requirement issues. Within the technological issues in m-learning is the variety of platforms, hardware manufacturers, and mobile user interfaces as well as network reliability (Sarrab, et al., 2013).

Pedagogical concerns presented by m-learning include the challenge of the educator/content designer being cognizant of the challenge of the context of the learning (Sarrab et al., 2013). Because the technology is always there and always on (Ally, 2009), the technology can be invasive, but can also allow the learner to learn wherever they are and can choose the context so that the learning is meaningful (Sharples, 2000). Use can be constrained by screen size and the necessity to deliver content in short blocks rather than larger units of information (Parsons & Ryu, 2006). These blocks fragment learning time and learning is then divided into various phases which can obstruct meaningful learning and inhibit acquiring and accumulating knowledge leading to the desired outcomes (Denk, 2007).

Virtual reality/augmented reality

Simulations have long been used in educational settings. Virtual reality (VR) refers to an immersive and interactive experience based on graphic images in 3D generated in real time by a computer (Piovesan et al., 2012). Augmented reality (AR) is the ability to overlay computer graphics onto the real world (Billinghurst, 2002; Wu et al., 2013). One potential benefit for the use of VR or AR in education is the ability to engage in real-world problems using current information through simulations (Saidin et al., 2015).

Virtual reality provides a means for creating highly realistic, three-dimensional simulations with immersive and interactive features creating great potential for simulations in distance education (Georgiou et al., 2007). Virtual Reality Modelling Language (VRML) and browser plug-ins have made it possible to build virtual worlds accessible through the internet (de Lara & Alfonseca, 2011). Georgiou et al., (2007) defined the educational virtual environment as "one or more virtual worlds that offer multiple educational functionalities to each user-student [where] students can navigate, interact with virtual objects and study the educational material, which can be either a 3D model or even text, image, sound or video" (p. 308). Though continually improving, the technology is not fully developed, nor readily available for easy adaptation into distance education, but has the potential to create an experience that is unique and not an attempted recreation of an in-class experience (Miller, 2014).

As opposed to VR where the environment is computer generated, in AR the environment is real, but with the addition of computer-driven information and imagery (Lee, 2012). AR allows real and virtual objects to coexist and the user to interact with them in real-time (Bower et al., 2014; Saidin et al., 2015).

Clark (2001) noted there is consistent evidence that when one controls for instructional methods and novelty, there are no learning benefits from employing any specific medium to deliver instruction. Others argue that virtual reality and augmented reality are clearly different from prior technologies at least for training with military, industry, and K-16 use (Perez et al., 2006). There is great potential for use of virtual reality and augmented reality in informal education programming, and this literature review includes those within the larger umbrella of e-learning.

Distance and e-learning and informal learning institutions

In the search through the academic literature looking more broadly at distance education, there was very little that referenced distance education in informal learning institutions. Two very different considerations affect this: 1) most of the literature in distance education is grounded in academic organizations, and the researchers in those programs or departments; and 2) many informal education institutions' distance education programs are designed as one-offs for integration into or in support of curricular learning in school systems (cf. Bontempi & Smith Nash, 2012; Dragotto et al., 2006; Kraybill, 2015; Scanlon et al., 2005). We found some that referenced museums across an array of types of museums including science centers and museums, zoos, aquariums, history museums, botanical gardens, and art museums; a few were specifically about an institution or one type of institution (e.g.; Din, 2015; Gaylord-Opalewski & O'Leary, 2019; Korn et al., 2014; PEER Associates, 2015; Tisdale, 2015).

Some of the references used museums as an example: one article offered a hypothetical art history course where museums serve as the site for filming (Moore, 1993). Others reference museums and libraries as partners in a consortium of institutions offering online courses (Naidu, 2003; Saba, 2005). There are examples of "museum guides" providing data and displaying information about the institution as a part of a mobile-learning experience (Pinkwart et al., 2003) and a virtual exhibit duplicating a real-world museum (Dede, 1996). Museums also get noted as sites to support distance learning (e.g. Valcke & Leeuw, 2000) and as sources for online content (Ascough, 2002; Burgstahler, 2002).

Bontempi & Smith Nash (2012) noted that museums are generally latecomers to distance learning as they historically have been dependent on a physical visit for providing access to their collections. The emergence of newer technologies, however, is allowing for virtual galleries, new options for the representation of objects and

specimens, and possibilities for exploration, interpretation, and knowledge about collections and museum expertise. For decades, distance programming at informal education institutions was primarily for schools. The Philadelphia Museum of Art, for example, conducted a 20-year reflection to think forward on its distance education school programs (O'Leary, 2015). The Wildlife Conservation Society similarly had an evaluation of their long-standing distance learning program for schools with a recommendation for a future-focused digital learning and engagement plan (PEER Associates, 2015).

Miller (2000) discusses museums using technology to teach students removed from their locations. One example was a cable television program series done by the Museum of Science Boston for elementary school teacher staff development in which participant teachers in the studio classroom served as a proxy for the teachers watching and as models for those teachers to compare themselves against. She also referenced "Science by Mail," an NSF-funded project in which a cadre of scientists online corresponded with youth involved in project tasks sent out as kits. Scores of zoos, aquariums, science centers, and botanical gardens have offered videoconferencing for years primarily as outreach programming, and for these, some evaluations are accessible through *informalscience.org* (e.g., Borun, 2008; PEER Associates, 2015; Tisdal, 2015). White papers 2 and 3 in this review include more references and examples of informal learning institutions and distance learning.

Technology allows for informal institutions, learners, and visitors to experience the institution in a different way, and there is a need for museums to be leaders in developing new approaches to these technologies (Din, 2015). Similarly, there are calls for the integration of asynchronous digital media to integrate with the synchronous distance learning programs of these institutions, and to integrate all the distance education tools the institution has (Houston, 2021). The lack of literature on informal distance learning reinforces the observation by Garrison & Archer (2007) and many others that ongoing research and theory development is needed to understand and move forward the educational practices made possible by highly interactive communications technologies.

Implications for informal learning institutions

The pandemic resulting from the spread of the SARS CoV-19 virus pushed all educational organizations and institutions into rethinking how they reach their learners. While the history and lessons learned above and in the following two white papers give a strong foundation of what is known about distance learning, schools, museums, industrial training programs and all sources of educational engagement directly between educator and learner came to a halt, and a faltering and shifting reboot. In the immediacy of the pandemic, institutions and individuals did not take time to look at the history and literature around distance education and distance learning, but by necessity had to adapt even as the world kept shifting.

This sudden opportunity to use technology for education and outreach provides a bit of an opportunity to look at how what is known and what is done and then reported on in the emergent literature of the moment reflects or does not reflect what came before. This component of the review is intentionally more broadly presented and is to highlight the very human nature of learning via distance, and to look for questions and insights that might add to the collective understanding, especially questions of how, and the value of informal science education institutions might use distance learning more effectively.

As mentioned in the history discussion, distance education has primarily been associated with formal education. Yet what are called informal science learning[1] organizations and institutions have been using distance education tools and processes for decades. An important question is, what has been learned through the extensive study of distance education in formal settings that will transfer to informal contexts? This is especially true given the component of the definition of distance education that aligns it with formal education organizations.

The history of distance education shows us that for every technological advance or addition to the suite of teaching resources, the challenges of the teaching/learning exchange when the teacher is distant remain. While each technology has its affordances and its limitations, distance education must focus on *how the person on the other end of the learning exchange interacts* with 1) the medium, 2) the platform, 3) the information/content, 4) other learners, and 5) the teacher. While opportunities for access across time and space have increased, the context for the learner has also increased, and boundaries between what is the learning event and what is other activity have been removed.

Likewise, from broadcast to wireless, the literature reminds us that the technology itself affects *the nature of learner participation*. The social dynamic and the way in which the learner engages and feels present in the teaching/learning exchange are important considerations in understanding distance learning (Ascough, 2002).

Distance education has always been mediated by the use of technology which can, by itself, "blind us to the needs of students and the need for good pedagogy. Technology becomes most potent when we can no longer see it" (Anderson & Simpson, 2012, p. 6). For informal educators, the exchange being part of a course of study reminds us of the importance of understanding that the distance education program is *part of a larger curriculum of the learner*. Whether it is a school-based curriculum, part of a circular curriculum for an institution or a suite of programs, or part of an individual's life-long/life-wide learning, the exchange is not a one-off experience. Good pedagogy and good andragogy in informal learning must be concerned with the context in which

---

[1] This review is using the common phrases "informal science" and "informal learning" to include science education institutions that are designed primarily for informal and nonformal learning structures (as per Mocker & Spear, 1982, Heimlich, 1993; Gupta et al., 2023); and as defined in use as informal science learning by museums and science centers (Carliner, 2012, 2013).

the learning happens, including the context of how the information/learning outcomes are or are not relevant in the learners' lives.

Distance education has shown repeatedly that while how people learn does not change, teaching is changed when a necessary component of the teaching model changes. For example, "models applicable in the classroom or via educational television are not necessarily applicable in the differently interactive environments of the Internet and the web" (Passerini & Granger, 2000, p. 12). The questions in informal education related to distance education start with *positioning the learning outcomes in the context of the learner, and understanding the affordances and limitations of the technology in helping the learner achieve those outcomes*. The lessons learned over time tell us that understanding teaching and learning via distance requires thinking of teaching *and* learning as continua: as one model suggests, teaching is either one-way (e.g. lecture or a lab class), or two-way; synchronous or asynchronous. And the media range from face-to-face to digital (Bates, 2005).

The technologies and resulting tools of distance education are seen as cumulative more than changing, making all the technologies resources for building a strong distance learning program, event, activity, or course. Distance education programs and courses should use the technologies appropriate for the learner, the content, and the intended outcomes. Though the history of distance education is about technologies, the purpose of distance education is about the learning and what can facilitate an individual learning with the instructor at a distance. White Paper #2 of this literature review explores what has been learned over time about creating a strong learning experience over distance. And following the model in the literature, we do not refer to this as virtual learning because the learning itself is real. Rather we acknowledge that it is distanced learning with similarities and differences based on the technologies employed. Finally, White Paper #3 shares what has been learned about evaluation and measuring distance learning and the implications for informal learning institutions.

Conclusion

In reflecting on his career in distance education, Ljoså (1992) acknowledged the general sense in the early 1970s that correspondence courses were becoming a thing of the past. By the 1990s, the thinking about education and technologies in general had changed and the label of correspondence course that had been used in the past had shifted to distance education to reflect its new role enabled by the emerging technologies. This shift was relatively rapid, but progressed in a way that reveals how the early concept of correspondence courses have, over the course of two centuries, morphed into a pervasive component of education in the 21st century. Over the last 50 years, the educational, two-way television of the 70s gave way to satellites, and then

correspondence courses took on a new look and presence with the advent of electronic mail in the 1980s. Email and computer conferencing systems emerged with the growth of access to and use of individual computers. In the email systems, the physical communication was electronic distribution of the course/workshop/program content materials, and then responses via reply to the educator (Holmberg 1995a). Other innovations in technology such as telewriters which used a sensitive pen to draw directly on a screen or scribble pad and transmitted over telephone lines (McConnell & Sharples, 1983) and electronic white boards which were used to serve groups of students over individual educator-student interactions (Tuckey, 1993) became integrated into computer-based distance education platforms. The ongoing evolution of personal technologies expands the opportunities for connecting educators to learners, and each has its pros and cons. As noted in the progression of the field, each new or adapted technology finds its place in the canon of tools for distance education. "Whatever technological progress is made, however, two-way communication in writing, which leads to instructional comments, suggestions, and, at an advanced level, scholarly analysis, remains a core medium. Ordinary reading and writing remain the basic means of student—tutor instruction" (Holmberg, 1995a, p. 121). With video, SMS, telephone, various audio, and other technologically driven tools as supports, this is less so for informal learning and training than it is for formal education programming.

Although history tells us why distance education emerged and has changed (and not changed) over time, it does not tell us why distance education continues to be an important tool for formal education and training, and increasingly in nonformal and informal learning institutions and organizations. Some authors note the benefits of reducing overcrowding in remote classrooms, reducing financial burdens for colleges and universities, and reducing costs for industrial training (Harper et al, 2004). Others suggest offering learners convenience of time and place (Mielke, 1999), and allowing individuals, in some cases, to move at their own pace (Hentea et al., 2003). Through much of its overall history, distance education "flourished in the spirit of social betterment and integration" and only in the more recent decades of faster, more accessible technology has it "become a tool for individual or commercial betterment in learning institutions and corporate training" (Berman, 2008, p. 1) with far easier means of customizing and personalizing learning (Hentea et al., 2003).

Increasingly, distance education is moving toward a networked learning environment integrating voice, video, and data connections among what is learned, instructors, experts, the Internet, virtual libraries, and other support services (Chute, et al., 1997). And as Bates (2005) reminds us, newer technologies are not better or worse than prior technologies, just different.

While the history of distance education is relatively easy to trace, the issues facing distance education are complex (Cannell, 1999). Moore (1993, p. 4) offers a framework for better considering distance learning. This "total systems perspective" examines the components of distance education in relationship, starting with the sources of the knowledge such as schools, corporations, and universities, the

processes of planning instructional programs, and the delivery of the program through a variety of media. Course designers and media experts create the activities for the learner groups and the individual learners, who in turn are supported by expert educators. And the goals of the system are, of course, the learning outcomes for the individuals.

References

Abas, Z.W., Lim, T. & Woo, T-K. (2009). Mobile learning initiative through SMS: A formative evaluation. *ASEAN Journal of Open and Distance Learning, 1*(1), 49 – 58.

Ally, M., Ed. (2009). *Mobile learning: Transforming the delivery of education and training.*AU Press, Issues in Distance Education Series. Edmonton, Alberta.

Anderson, D. R. (1998). Educational television is not an oxymoron. *The Annals of the American Academy of Political and Social Science*, *557*(1), 24-38.

Anderson, B., & Simpson, M. (2012). History and heritage in open, flexible, and distance education. *Journal of Open, Flexible and Distance Learning, 16*(2), 1–10.

Ascough, R.S. (2002). Designing for online distance education: Putting pedagogy before technology. *Teaching Theology and Religion, 5*(1), 27-29.

Banas, E.J. & Emory, W.F. (1998). History and issues of distance learning. *Public Administration Quarterly, 22*(3), 365-383.

Bansal, P., Bertels, S. Ewart, T., MacConnachie, P. & O'Brien, J. (2012) Bridging the research-practice gap. *Academy of Management Perspectives, 26*(1), 73-92.

Bates, A.T. (2005). *Technology, e-learning and distance education*. Routledge.

Bates, A.W. & Picard, J., (2005). Audio-, video- and Web-conferencing: access and teaching issues. In A.W. Bates. *Technology, E-learning and Distance Education*. Routledge. pp. 175-209.

Bensen, R., & Samarawickrema, G. (2009). Addressing the context of e-learning: Using transactional research theory to inform design. *Distance Education, 30*(1), 5-21.

Bergmann, H.F. (2001). "The silent university:" The Society to Encourage Studies at Home, 1873-1897. *The New England Quarterly, 74*(3), 447-477.

Berman, S.D. (2008). The return of educational radio? *International Review of Research in Open and Distance Learning, 9*(2).
irrodl.org/index.php/irrodl/article/view/563/1038

Billinghurst, M. (2002). Augmented reality in education. *New horizons for learning*, *12*(5), 1-5.

Black, L.M. (2004). *A living story of the origins and development of scholarship in the field of distance education.* Unpublished Doctoral Dissertation, The Pennsylvania State University.

Bontempi, E. & Smith Nash, S. (2012). Effective strategies in museum distance education. In *InSITE 2012: Informing Science & IT Education Conference. 12,* 13-25.

Borun, M. (2008). *Grossology LIVE! Summative evaluation.* The Franklin Institute, Philadelphia, PA.

Bower, B.L. & Hardy, K.P. (2004). From correspondence to cyberspace: Changes and challenges in distance education. *New Directions for Community Colleges.* 128, 5-12.

Bower, M., Howe, C., McCredie, M., Robinson,A. & Grover, D. (2014). Augmented reality in education – Cases, places and potentials. *Educational Media International, 51*(1), 1-15.

Bozkurt, A. (2019). From distance education to open and distance learning: A holistic evaluation of history, definitions, and theories. In S. Sisman-Ugur, & G. Kurubacak (Eds.), *Handbook of Research on Learning in the Age of Transhumanism* (pp. 252-273). Hershey, PA: IGI Global.

Bretz, R. (1971). *A taxonomy of communication media.* Englewood Cliffs, NU: Educational Technology Publications.

Bretz, R. (1972). *The MODIA questionnaire for curriculum analysis.* Santa Monica: Rand Corporation.

Broekkamp, H. & van Hout-Wolters, B. (2007). The gap between educational research and practice: A literature review, symposium, and questionnaire, *Educational Research and Evaluation,* 13(3), 203-220.

Buck, G.H. (2006). The first wave: The beginnings of radio in Canadian distance education. *Journal of Distance Education, 21*(1), 75-88.

Burgstahler, S. (2002). Distance learning: Universal design, universal access. *AACE Journal, 10*(1), 32-61.

Cannell, L. (1999). A review of literature on distance education. *Theological Education, 36*(1), 1-72.

Carliner, S. (2012). *Informal learning basics.* ASTD Press.

Carliner, S. (2013). How have concepts of informal learning developed over time? *Performance Improvement, 52*(3), 5-11.

Casey, D. M. (2008). A journey to legitimacy: The historical development of distance education through technology. *TechTrends, 52*(2), 45-51.

Caudill, J. G. (2007). The growth of m-learning and the growth of mobile computing: Parallel developments. International Review of Research in Open and Distance Learning, 8(2). http://www.irrodl.org/index.php/irrodl/article/view/348/873

Chute, A.G., Sayers, P.K. & Gardner, R.P. (1997). Networked learning environments. *New Directions for Teaching and Learning, 71*(Fall), 75-83.

Clark, R.E. (1975). Constructing a taxonomy of media attributes for research purposes. *AV Communication Review, 23*(2), 197-215.

Clark, R.E. (2001). New directions and evaluating distance learning technologies. In R.E. Clark (Ed.), *Learning from media: Arguments, analysis, and evidence*. Greenwich, CT: Information Age Publishers.

Clark, T. (2003). Virtual and distance education in American schools. In M.G. Moore & W.G. Anderson (Eds.), *Handbook of Distance Education*. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers, pp. 673-699.

Daniel, J. (1998). *Mega-universities and Knowledge Media*. Routledge Falmer.

De Lara, J. & Alfonseca, M. (2011). Using simulation and virtual reality for distance education. *Computers and Education: Twoards and Interconnected Society, 2,* 199-206.

DEAC (2021). DEAC history. Distance Education Accrediting Commission. https://www.deac.org/Discover-DEAC/DEAC-History.aspx

Dede, C. (1996). The evolution of distance education: Emerging technologies and distributed learning. *American Journal of Distance Education, 10*(2), 4-36.

Demiray, U. (2003). Defining distance education. In İşman, A., Barkan, M., & Demiray, U. (Eds.) *Online Distance Education Book*. TOJET. Retrieved from http://www.tojet.net/e-book/ebook.htm#2

Denk, M. (2007). Mobile learning – challenges and potentials. *International Journal of Mobile Learning and Organisation Archive. 1*(2), 122-139.

Din, H. (2015). Pedagogy and practice in museum online learning, *Journal of Museum Education, 40*(2), 102-109.

Dragotto, E., Minerva, C. & Nichols, M. (2006). Is museum education "rocket science"? *Journal of Museum Education, 31*(3), 215-222.

Flinck, R. (1978). Correspondence education combined with systematic telephone tutoring. ERIC.

Freeman, S., Marston, H. R., Ross, C., Morgan, D. J., Wilson, G., Gates, J., ... & McAloney, R. (2022, September). Progress towards enhanced access and use of technology during the COVID-19 pandemic: A need to be mindful of the continued digital divide for many rural and northern communities. In *Healthcare Management Forum* (Vol. 35, No. 5, pp. 286-290). Sage CA: Los Angeles, CA: SAGE Publications.

Fresen, J.W. (2007). A taxonomy of factors to promote quality web-supported learning. *International Journal on E-Learning, 6*(3), 351-362.

Garrison, D. R., & Archer, W. (2007). A theory of community of inquiry. In M. G. Moore (Ed.) *Handbook of distance education* (2nd ed., pp. 77– 88). Lawrence Erlbaum Associates.

Gaylord-Opalewski, K. & O'Leary, L. (2019). Defining interactive virtual learning in museum education: A shared perspective. *Journal of Museum Education, 44*(3), 229-241.

Georgiou, J., Dimitropoulos, K. & Manitsaris, A. (2007). A virtual reality laboratory for distance education in chemistry. *International Journal of Social and Human Sciences., 2*(1), 34-41.

Gupta, R., Voiklis, J., de la Torre Dwyer, J., Flinner, K. Fraser, J. & Thomas, U.G. (2023). What is the STEM learning ecology and where do zoos and aquariums fit in it? Insights from national studies of the public's engagement with science, technology, engineering, and math. In J. Fraser, J.E. Heimlich & K. Riedinger (Eds.) *Understanding Zoos and Aquariums in the Public Mind*. Springer. pp. 65-78.

Hanna, D.E. (2003). Organizational models in higher education, past and future. In M.G. Moore & W.G. Anderson, (Eds.). *Handbook of Distance Education*. Lawrence Earlbaum Associates, Publishers. pp 67-78.

Harper, K.C., Chan, K. & Yen, D.C. (2004). Distance learning, virtual classrooms, and teaching pedagogy in the internet environment. *Technology in Society,* (2004), 585-598.

Harting, K. & Erthal, M.J. (2005). History of distance learning. *Information Technology, Learning, and Performance Journal, 23*(1), 35-44.

Hayes, P., Joyce, D., & Pathak, P. (2004). *Ubiquitous learning – An application of mobile technology in education*. World Conference on Educational Multimedia, Hypermedia and Telecommunications (EDMEDIA) 2004, Lugano.

Heimlich, J.E. (1993). Nonformal environmental education: Toward a working definition. *The Environmental Outlook* ERIC Clearinghouse for Science, Mathematics, and Environmental Education. Informational Bulletin ED360154,

Heimlich, J. E., Nowak, P. Jr., & Wang, K. (1999). *Finding Resources on the Internet: A Trainer's Module for Environmental Education*. The EETAP Resource Library. Eric Clearinghouse for Science, Mathematics, and Environmental Education. Columbus, The Ohio State University. ED462303.

Heller, R.S. & Martin, C.D. (1995). A media taxonomy. *IEEE MultiMedia, 2*(4), 36-45.

Hentea, M., Shea, M. J., & Pennington, L. (2003). A perspective on fulfilling the expectations of distance education. In *Proceedings of the 4th conference on Information technology curriculum* (pp. 160-167).

Hershey, M. (1977). Telephone instruction: An alternative educational delivery system for teacher in-service. *The Gifted Child Quarterly, 21*(2), 213-217.

Holmberg, B., (1987). The development of distance education research. *The American Journal of Distance Education, 1*(3), 16-23.
Holmberg, B. (1989). Key issues in distance education: An academic viewpoint. *European Journal of Education, 24*(1), 11-23.

Holmberg, B. (1995). *Theory and practice of distance education*. Second Edition. New York: Routledge.

Holmberg, B. (1995a). The evolution of the character and practice of distance education. *Open Learning: The Journal of Open, Distance and e-Learning, 10*(2), 47-53.

Horrigan, J. (2014). Schools and broadband speeds: An analysis of gaps in access to high-speed internet for African American, Latino, low-income, and rural students. *Alliance for Excellent Education*.

Houston, M. (2021). Facilitating digital transformation for museum education in response to COVID-19. *New England Museum News.*

Inglis, A. (2003). A comparison of online delivery costs with some alternative distance delivery methods. In M.G. Moore & W.G. Anderson, (Eds.). *Handbook of Distance Education*. Lawrence Earlbaum Associates, Publishers.

Kanuka, H. & Conrad, D. (2003). The name of the game: Why 'distance education' says it all. *The Quarterly Review of Distance Education. 4*(4), 385-393.

Keegan, D. (1988). Concepts: Problems in defining the field of distance education. *American Journal of Distance Education, 2*(2), 4-11.

Kentnor, H. (2015). Distance education and the evolution of online learning in the United States. *Curriculum and Teaching Dialogue, 17*(1&2). 21-34.

King, F. B., Young, M. F., Drivere-Richmond, K., & Schrader, P. G. (2001). Defining distance learning and distance education. *AACE journal*, *9*(1), 1-14.

Korn, R., Skidmore, E. & Craig, E. (2014*). Annotated bibliography: Scaling up and distance education*. National Air and Space Museum. Randi Korn & Associates, Inc.

Korthagen, F.A.J. (2007) The gap between research and practice revisited, *Educational Research and Evaluation,* 13(3), 303-310.

Kozma, R.B. (1994). Will media influence learning? Reframing the debate. *Educational Technology Research and Development, 42*(2), 7-19.

Kraybill, A. (2015). Going the distance: Online learning and the museum. *Journal of Museum Education, 40*(2), 97-101).

Kumar, S. (2013). M-learning: A new learning paradigm. *International Journal on New Trends in Education and their Implications, 4*(2), 65-78.

Lease, A.J. & Brown, T.A. (2009). Distance learning: Past, present and future. *International Journal of Instructional Media, 36*(4), 415 – 426.

Lee, K. (2012). Augmented reality in education and training. *TechTrends, 56*(2), 13-21.

Li, H. & Masters, J. (2009). E-Learning and knowledge management in the early years: Where are we and where should we go. *Knowledge Management & E-Learning: An International Journal, 1*(4), 245-250.

Ljoså, E. (1992). Distance education in a modern society. *Open Learning: The Journal of Open, Distance and e-Learning, 7*(2), 23-30.

Lolis, K. (1968). *Evaluation of a method of school-to-home telephone instruction of physically handicapped, homebound adolescents*. New York: Board of Education of the City of New York.

Malone, L. J. (2001). Commonalities: The REA and high-speed rural Internet access. *arXiv preprint cs/0109064.*

Marcus, S. (2004). Leadership in distance education: Is it a unique type of leadership? A literature review. Online Journal of Distance learning Administration. Retrieved from http://www.westga.edu/~distance/ojdla/spring71/marcus71.html

McConnell, D. & Sharples M. (1983). Distance teaching by Cyclops: An educational evaluation of the Open University's telewriting system. *British Journal of Educational Technology, 2*(14), 109 -126.

McIsaac, M.S., & Gunawardena, C.N. (2013). Distance education. In Jonassen, D.H. (Ed). *Handbook of research for educational communications and technology. 403,* 437.

Mehrotra, C., Hollister, D., & McGahey, L. (2001). *Distance learning: Principles for effective design, delivery, and evaluation.* Sage Publications, Thousand Oaks, CA. Communications
Meredith, P. (1965). Toward a taxonomy of educational media. *AV Communication Review, 13*(4), 374-384.

Mielke, D. (1999). Effective teaching in distance education. *ERIC Digest.* Washington, DC: ERIC Clearinghouse on Teaching and Teaching Education (ERIC Identifier ED436528).

Miller, I. (2000). Distance learning – A personal history. *Internet and Higher Education, 3*( ), 7-21.

Miller, R. (2014). The application of virtual reality in higher education distance learning. *Journal of Applied Learning Technology, 4*(4), 15-18.

Mocker, D.W. & Spear, G.E. (1982). *Lifelong learning: Formal, nonformal, informal, and self-directed (Information Series No. 241).* ERIC Clearinghouse for Adult and Vocational Education.

Moeller, B. (1996). Learning from television: A research review. *CCT Reports, 11*(October). Center for Children & Technology.

Moore, J.L., Dickenson-Deane, C. & Galyen, K. (2011). e-Learning, online learning, and distance learning environments: Are they the same? *Internet and Higher Education, 14*(2), 129-135.

Moore, J.L., Dickenson-Deane, C., Galyen, K. & Chen, W. (2010). Designing for e-learn, online, and distance learning environments: Are they the same? Conference paper. American Educational Research Association. (16) (PDF) Designing for E-learn, Online, and Distance Learning Environments: Are They the Same? (researchgate.net)

Moore, M.G. (1991). Editorial: Distance education theory. *The American Journal of Distance Education, 5*(3), 1-6.

Moore, M.G. (1993). Editorial: Is teaching like flying? A total systems view of distance education. *The American Journal of Distance Education. 7*(1), 1-10.

Moore, M.G. (2003). Editorial: The handbook of distance education. *The American Journal of Distance Education, 17*(2), 73-75.

Moore, M.G. & Anderson, W.G. (2003). *Handbook of distance education*. Lawrence Earlbaum Associates, Publishers. Mahwah, N.J.

Moore, M.G. & Kearsley, G. (2012). *Distance education: A systems view of online learning, Third edition*. Wadsworth.

Motiwalla, L.F. (2007). Mobile learning: A framework and evaluation. *Computers & Education, 49*(2007), 581-596.

Naidu, S. (2003). Designing instruction for e-learning environments. In M.G. Moore & W.G. Anderson (Eds.) *The Handbook of Distance Education*. Lawrence Earlbaum Associates, Publishers. pp 349-365.

O'Leary, L. (2015). Insights on a museum's distance learning program. *Journal of Museum Education, 36*(3), 241-247.

Olgren, C.H. (1997). Teaching by telephone. *New Directions for Teaching and Learning 71*(Fall), 59-66.

Ostendorf, V.A., (1997). Teaching by television. *New Directions for Teaching and Learning 71*(Fall), 51-58.

Pant, A. (2014). Distance learning: History, problems and solutions. *Advances in Computer Science and Information Technology, 1*(2), 65-70.

Parsons, D., & Ryu, H. (2006). A framework for assessing the quality of mobile learning.
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.108.2612&rep=rep1&type=pdf

Passerini, K & Granger M.J. (2000). A developmental model for distance learning using the Internet. *Computers & Education, 34*(1), 1-15.

PEER Associates, Hardee C. & Duffin, M. (2015). *Summary of evaluation findings: Digital programming in informal science settings, current trends and practices*. Downloaded from PEERassociates.net.

Perez, R.S., Gray, W. & Reynold, T. (2006) Virtual reality and simulators: Implications for web-based education and training. In H.F. O'Neil & R.S. Perez (Eds.), *Web-based Learning: Theory, Research, and Practice*. Lawrence Erlbaum Associates, Publishers.

Phipps, R. & Merisotis, J. (1999). *What's the difference? A review of contemporary research on the effectiveness of distance learning in higher education*. Prepared for the American Federation of Teachers and the National Education Association. Washington, D.C.: The Institute for Higher Education Policy.

Pinkwart, N., Hoppe, H. U., Milrad, M., & Perez, J. (2003). Educational scenarios for cooperative use of Personal Digital Assistants. Journal of Computer Assisted Learning, 19(3), 383-391.

Piovesan, S.D., Passerino, L.M. & Pereira, A.S. (2012). Virtual reality as a tool in the education. International Conference on Cognition and Exploratory Learning in Digital Age. *International Association for Development of the Information Society*.

Pittman, V.V. (2003). Correspondence study in the American university: A second historiographic perspective. In M.G. Moore & W.G. Anderson, (Eds). *Handbook of distance education*. Lawrence Earlbaum Associates, Publishers. Mahwah, N.J., pp 21-36.

Puzzuoli, D.A. (1970). *A study of teaching university extension classes by tele-lecture*. Morgantown: West Virginia University Office of Extension Credit and Non-Credit Programs, Center for Appalachian Studies and Development.

Rumble, G. (1989). Concept: On defining distance education. *American Journal of Distance Education*, *3*(2), 8-21.

Saba, F. (2005). Critical issues in distance education: A report from the United States. *Distance Education, 26*(2), 255-272.

Saidin, N.F., Dayana, N., Halim, A., & Yahaya, N. (2015). A review of research on augmented reality in education: Advantages and applications. *International Education Studies, 8*(13), 1-8.

Salomon, G. (1984). Television is "easy" and print is "tough": The differential investment of mental effort in learning as a function of perceptions and attributions. *Journal of Educational Psychology, 76*(4), 647-658.

Sarrab, M., Al-Shihi, H,. & Rehmman, O.M.H. (2013). Exploring major challenges and benefits of m-learning adoption. *British Journal of Applied Science & Technology, 3*(4), 826-839.

Scanlon, E., Jones, A., & Waycott, J. (2005). Mobile technologies: prospects for their use in learning in informal science settings. *Journal of Interactive Media in Education, 21*(5), 1-17.

Sewart, D. (1993). Student support systems in distance education. *Open Learning: The Journal of Open, Distance and e-Learning. 8*(3), 3-12.

Sharples, M. (2000). The design of personal mobile technologies for lifelong learning. *Computers & Education, 34,* 177-193.

Shearer, R. (2003). Instructional design in distance education: An overview. *Handbook of distance education,* 275-286. In M.G. Moore & W.G. Anderson, (Eds). *Handbook of distance education.* Lawrence Earlbaum Associates, Publishers. Mahwah, N.J., pp 275-286.

Simonson, M. (1999). Equivalency theory and distance education. *TechTrends, 43*(5), 5-8.

Simonson, M. (2009). Distance learning. In *The 2009 book of the year: Encyclopedia Britannica. p.231*

Simonson, M., Smaldino, S., Albright, M., and Zvacek, S. (2000). *Teaching and Learning at a Distance: Foundations of Distance Education.* Prentice Hall.

Simonson, M., Zvacek, S. & Smaldino, S. (2019). *Teaching and learning at a distance: Foundations of distance education.* Seventh Edition. Information Age Publishing.

Sumner, J. (2000). Serving the system: A critical history of distance education. *Open Learning: The Journal of Open, Distance, and e-learning. 156*(3), 267-285.

Talebian, S., Mohammadi, H.M., & A. Rezvanfar. (2014). Information and communication technology (ICT) in higher education: Advantages, disadvantages, conveniences and limitations of applying e-learning to agricultural students in Iran. *Procdedia: Social and Behavioral Sciences. 152,* 300-305.

Taylor, J. C. (2001). Fifth generation distance education. *Instructional Science and Technology, 4*(1), 1-14.

Tetard, F., Patokorpi, E., & Carlsson, J. (2008). *A conceptual framework for mobile learning* (Research report 3/2008). AInstitute of Advanced Management Systems Research, Abok Akademi University.

Thomas, C. N., Peeples, K. N., Kennedy, M. J., & Decker, M. (2019). Riding the special education technology wave: Policy, obstacles, recommendations, actionable ideas, and resources. *Intervention in School and Clinic, 54*(5), 295-303.

Tisdal, C.E. (2015). *Distance learning programs at the St. Louis Zoo: Focus groups with teachers of K-12 students with disabilities*. St. Louis: Tisdal Consulting.

Tosti, D.T. & Ball, J.R. (1969). A behavioral approach to instructional design and media selection.. *Audio-visual Communication Review, 17*(1), 5-25.

Traxler, J. (2005). Defining mobile learning. *Proceedings of the IADIS International Conference Mobile Learning 2005*. pp 261 – 266.

Traxler, J. (2007). Defining, discussing, and evaluating mobile learning: The moving finger writes and having writ… *International Review of Research in Open and Distance Learning, 8*(2), 1 – 12.

Tuckey, C.J. (1993). Computer conferencing and the electronic white board in the United Kingdom: A comparative analysis. *American Journal of Distance Education, 7*(2), 58-72.

Valcke, M.M. & Leeuw, F.L. (2000). *Evaluating digital distance learning programs and activities*. Washington, World Bank Institute.

Vanderlinde, R. & van Braak, J. (2013). The gap between educational research and practice: Views of teachers, school leaders, intermediaries and researchers. *British Educational Research Journal. 36*(2), 299-316.

Verduin, J.R. Jr. & Clark, T.A. (1991). *Distance education: The foundations of effective practice*. Jossey-Bass.

Whitacre, B. E., & Mills, B. F. (2010). A need for speed? Rural Internet connectivity and the no access/dial-up/high-speed decision. *Applied Economics, 42*(15), 1889-1905.

Wilson, B., Sherry, L., Dobrovolny, J., Batty, M., & Ryder, M. (2002). Adoption of learning technologies in schools and universities. In H. H. Adelsberger, B. Collis, & J. M. Pawlowski (Eds.), *Handbook on information technologies for education & training*. New York: Springer-Verlag.

Wisher, R.A. & Curnow, C.K. (2003). Video-based instr4uction in distance learning: From motion pictures to the internet. In M.G. Moore & W.G. Anderson, (Eds). *Handbook of distance education*. Lawrence Earlbaum Associates, Publishers. Mahwah, N.J., pp 315-330.

Wong, D. (2007). A critical literature review on e-learning limitations. *Journal for the Advancement of Science and Arts, 2*(1), 55-62.

Woolsey, F.M. (1958). Two years of experience with two-way radio conferences for postgraduate medical education. *Journal of Medical Education, 33*(6), 474-482.

Wu, HK., Lee, S.WY., Chang, H., Liang, J. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*, 41-49

Yousafzai, A., Change, V., Gani, V. & Md Noor (2016). Multimedia augmented m-learning: Issues, trends and open challenges. *International Journal of Information Management, 36*(5), 784-792.