OUTSIDE THE PREPARED ENVIRONMENT: HOW MONTESSORI TEACHER TRAINING INFLUENCES PRACTITIONER ATTITUDES TO TECHNOLOGY

by

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WE, THE UNDERSIGNED MEMBERS OF THE COMMITTEE,

HAVE APPROVED THIS DISSERTATION

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ACCEPTED AND APPROVED ON BEHALF

OF WILLIAM HOWARD TAFT UNIVERSITY

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Abstract

This quantitative causal-comparative research study addresses the question of whether a teacher's training background is related to a difference in their attitude toward educational technology. This study specifically targeted Montessori Early Childhood Educators during the COVID-19 pandemic and compared their scores on each of nine subscales on the Teacher Attitudes to Computers (TAC) and Teacher Attitudes to Technology (TAT) survey instruments. Participants were recruited from Montessori-specific Facebook groups and were grouped by their own training background, namely face-to-face, blended, and online. In the study, 214 participants took part of which 76 were trained face-to-face, 63 were trained in a blended format, and 64 were trained in an online format. Differences were analyzed using a one-way ANOVA between pairings of each of the three training backgrounds. Differences were found among each of the three groups in terms of their scores on each of the nine subscales of the TAC/TAT, with the widest gap between those who experienced face-to-face training and those who experienced online training. Further research is needed to gain more insight into the specific experiences of Montessori Early Childhood Educators in reference to their attitudes toward technology and their impact on practice during the COVID-19 pandemic and beyond.

Dedication

This dissertation is dedicated to the many teachers, both professional and personal, who have shaped my understanding of the human condition and inspired me to take on new challenges. As with Isaac Newton, “If I have seen further, it is by standing on the shoulders of giants.”

Acknowledgements

I acknowledge all of the many individuals and organizations that have supported my personal and professional growth. The staff and community of Ganeinu International School provided me with a solid foundation in the Montessori method, which eventually became the focus of my research. The professional learning community at Dehong International Chinese School has given me the tools and the time to devote to this extensive undertaking. Finally, the professors at William Howard Taft, including my committee chairperson, Dr. Jillian Skelton, and committee members Dr. Aleta Ledendecker and Dr. Mindy Payton, for their valuable insights and attention.

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Chapter 1

The Problem

The emergence of the novel corona virus as a global pandemic has prompted emergency school closures around the world. Teachers and students all over the world have been confronted with a quick shift from in-person learning to distance learning, utilizing new technologies as well as putting old technologies to new use (Andrew et al., 2020; Atiles et al., 2021). The ability of teachers to adapt to these new conditions, as well as to provide and present an alternative method of access to their traditional classroom practices, has raised concerns over the practical and pedagogical implications for learners at all levels (Organisation for Economic Co-operation and Development [OECD], 2020).

While the global pandemic was unprecedented in terms of its effects on educational institutions worldwide, various trends toward greater integration of technological tools with traditional classroom experiences have created deep divides in many professional learning communities over the pedagogical consequences of these shifts (Blackwell et al., 2014; Voogt et al., 2013). Teacher attitudes toward the use of technology in the classroom vary considerably, often influenced by their own experiences as learners and the theories of learning that inform their teaching (Duhaney, 2012). Drawing on decades of research on the ways in which teacher attitudes and comfort with technology influence their classroom practice, preservice and in-service teacher training programs have gained insight into how best to support teachers in identifying and adapting technological elements into their classroom practice (Amador et al., 2015).

However, the global pandemic presents a tangent to previous studies of teacher technology integration because previous research was largely based on inspiring positive buy-in

from schools and faculty in purposefully integrating technology in ways that reflected long-term goals and meaningful alignment with curriculum (Ozgur & Bayraktar, 2013). The global pandemic, on the other hand, because of its sudden appearance and the subsequently quick shifts to distance learning, reflects a reality quite different from the thoughtful process of technology adoption advocated in previous research (Campos & Vieira, 2021; Mantovani et al., 2021; Mitchell et al., 2020; Mochida et al., 2021). Rather than allocating time and resources to training and acclimating teachers before the fact, educational institutions and organizations reacted in real-time with a wide range of teacher preparation and skills (Barnett et al., 2021).

While teacher attitudes and familiarity with technology integration vary widely among different ages and backgrounds, early childhood educators faced unique challenges in terms of swiftly adapting to distance instruction (Kahuroa et al., 2021; O'Keeffe & McNally, 2021; OECD, 2020). With a focus on social and emotional skills and play-based curricula, Early Childhood education programs struggled to provide comparable services online (Brown et al., 2020; Egan et al., 2020). The attitudes of teachers in early childhood education programs to integrating technology into their distance learning programs often reflect their pedagogical influences, particularly their concerns about designing and developing authentic play-based learning experiences in an environment in which few, if any, trained (Brown et al., 2020; Kahuroa et al., 2021; May & Coulston, 2021).

While many progressive pedagogies based on constructivist principles have attained global recognition, the development of the Montessori teaching and learning framework retains many unique elements that define the ways in which teacher and student relationships drive classroom instruction (Culclasure et al., 2019; Rosenburg, 2015; Taggart et al., 2018). With a focus on hands-on, experiential learning, the Montessori mindset can often be at odds with the

use of technology in the classroom and as a means of teacher training (Scott & Glaze, 2017; Wafford & Rigaud, 2019). While the Montessori name refers to a general philosophy of education based on the ideas of its founder, Dr. Maria Montessori, rather than being commercially trademarked or institutionally accredited, the use of the term Montessori and the standardization of teacher training opportunities is quite loosely aligned (Lapon, 2020; Lillard & Eisen, 2017; Walls, 2018). This, in turn, leads to a wide range of teaching training methods, including online, blended, and face-to-face methods as well as a wide spectrum of international recognition of the Montessori credentials issued by a plethora of Montessori-branded organizations (Bennetts & Bone, 2020).

As Montessori-based learning enters its second century within the global landscape of educational reform and best practice, the ways in which Montessori educators can adapt and defend their pedagogical framework remains a key consideration in their continued advocacy for child-centered education (Burbank et al., 2020; Debs & Brown, 2017; Glass, 2017; Murray et al., 2019). The global pandemic offers a window into how teacher training and learning backgrounds influence Montessori educators in real time, as they struggle alongside other educators in adapting their pedagogy in ways that serve today's students where they are often distanced from the prepared classroom environment (Brown et al., 2020).

Background of the Problem

The perceived conflict between hands-on experiential pedagogy and the inauthentic integration of technology in the classroom has long remained a truism in many educational circles, particularly in early childhood education (Larson, 2014). Pedagogical frameworks based on constructivist principles have long advocated for experiential learning with authentic materials and challenges (Schunk, 2016; Ultanir, 2012). Early proponents of such principles,

such as Montessori, turned away from drill-based academic curricula toward building life skills through developmentally appropriate authentic learning activities (Lillard & McHughes, 2019a, 2019b).

Alongside the educational reform movements of progressive pedagogy, technological developments in the creation and dissemination of learning media and learning tools have also rapidly transformed the classroom experience of many students (Byker et al., 2017; Zeytep et al., 2019). The use of computers for various purposes, as well as the use of specially designed technological learning tools and programs, has brought with it many questions about the usefulness of integrating such tools into the classroom (Cuban & Jandric, 2015). In particular, the ways in which early childhood educators perceive the benefits and drawbacks of such technological tools often reflect their own pedagogical background and views on how children learn through interaction in the real world (Guillen-Gamez & Mayorga-Fernandez, 2020).

Much of the previous research on this perceived conflict between constructivist pedagogy and technology integration has examined the role of the educator as a mediator between school and student expectations as part of a long-term training and mentoring focus within traditional classroom practice (Anderson & Dron, 2012; Derbel, 2017; P. A. Ertmer et al., 2012; Heath, 2017; Kimmons et al., 2015). However, the conditions of the global pandemic present a contrast to the assumed conditions of this research (Caldwell, 2020). Rather than examining the available choices and the attitudes of teachers toward making choices most meaningful within their overall classroom expectations, the global pandemic has thrown into relief the ways in which teachers, with little or no preparation and with little or no time to consider or reflect on their choices, have faced the stark challenge of adapting or failing to adapt to distance learning requirements (Barnett et al., 2021; Formosinho, 2021; O'Keeffe & McNally, 2021; OECD, 2020).

Statement of the Problem

There are a range of factors that might or might not have an influence on the ability of an individual teacher to adapt to the new realities of teaching under the conditions of the global pandemic (Sang et al., 2010; Teo, 2011). This is equally true of Montessori educators, who also come from a range of backgrounds, including the ways in which they learn and practice a version of Montessori constructivist pedagogy (Fleming et al., 2019; Hargis & Hargis, 2020). While traditionally, high-quality teacher training in Montessori has focused on the face-to-face experience of learning within an established Montessori classroom, many online or blended alternatives have arisen during the previous decades (Bennetts & Bone, 2019, 2020). Determining the ideal balance between different types of training has long been an issue that has divided Montessori practitioners and theorists (Culclasure et al., 2019; Lillard, 2019; Marshall, 2017).

Much of the research on teacher attitudes toward technology integration is based on a narrative of choice and how to lead teachers toward making meaningful technology choices (P. A. Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010). The global pandemic has in many ways removed some of the element of choice and created a gap in the available research on how teacher attitudes toward technology influence teaching practice (Brown et al., 2020). Teachers who previously might have navigated their classroom experiences without technological choices find their traditional classroom practices upended in the process of adapting to distance learning, often against their personal choice or the choices of their students, parents, and so forth (Bertram & Pascal, 2021; Formosinho, 2021; Graber et al., 2020). While the attitudes and beliefs of teachers have been shown to be crucial in their willingness and ability to integrate technology, the ways in which these attitudes and beliefs are cultivated require further investigation (Darling-

Hammond et al., 2020; Hutchinson & Reinking, 2011; Jenkins et al., 2018; McConnell et al., 2013). This research study examines to what degree a teacher's personal training background influences their ability to adapt, with particular attention to their own background in an online, blended, or face-to-face teacher training program.

In examining the factors that influence the ability for a Montessori educator to adapt their classroom practices to the conditions of the global pandemic, namely online or blended learning experiences, the training background of the teacher may play a role in cultivating an open-minded and flexible attitude toward integrating technology into their repertoire of skills (Petko, 2012; Scherer et al., 2019). Though often considered lesser forms of teacher training in the established Montessori communities, online and blended teacher training provide an interesting area for reflection on how such programs might allow teachers to view the place of technology in constructivist pedagogy differently than those who did not have online or blended learning experiences in their own training (Joo et al., 2018; Riyanti, 2017). The problem of this quantitative causal comparative study is that it is unknown to what extent the training background of a Montessori teacher causes a difference in their attitude toward the use of technology in the classroom. This research seeks to compare how these different training backgrounds might cause a difference in attitudes toward technology integration in the classroom (Ozgur & Bayraktar, 2013; Teo & Zhou, 2016). The consequences of this research would be directed toward those Montessori-training institutions in their design of teacher preparation programs as they consider the balance among online, blended, and face-to-face instruction.

Purpose of the Study

This quantitative causal comparative study seeks to compare a teacher's own training background and their attitude toward adapting their classroom using technology during the

global pandemic. This study examines whether a teacher who experienced online or blended learning in their own teacher training has a comparatively different attitude toward using technology in the classroom than their face-to-face counterparts. This study hopes to identify to what extent there is a difference in the attitudes toward technology of teachers with different training backgrounds. Based on this research study, there might be possible considerations for teacher training institutes going forward in preparing teachers who can adapt constructivist pedagogies for challenging and changing conditions in global education.

Research Questions and Hypotheses

This quantitative causal comparative study seeks to compare the attitudes of Montessori teachers from different training backgrounds in order to determine if these training backgrounds result in different attitudes toward technology in the classroom. The independent variables are the three types of teacher training, namely online, blended, and face-to-face. The dependent variables are the scores on each subset of the Teacher Attitudes to Computers (TAC) and Teacher Attitude to Technology (TAT) survey instruments that measure teacher attitudes toward the use of technology. The null hypotheses tested are the difference between the type of teacher training program (online, blended, or face-to-face) and the scores on the TAT survey (R. Christensen, 2002; R. Christensen & Knezek, 1996, 1999, 2000a, 2000b, 2009; Knezek & Christensen, 1997, 1998, 2015). These are also cross-referenced for differences based on the demographic information collected on each participant in order to eliminate any tangential differences based on these factors.

The research question it seeks to clarify is:

RQ: Are there differences in attitudes to the integration of technology as measured on the TAC/TAT among teachers of three training backgrounds: online, blended, and face-to-face?

$H1_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

H1: There is a difference on one of more subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

$H2_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

H2: There is a difference on one of more subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

$H3_0$: There is no difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

H3: There is a difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

Importance of the Study

The global pandemic has created one of the greatest challenges to the educational experiences of teachers and students (Mantovani et al., 2021). Taking place in real time, the potential challenges and opportunities of the educational moment require ongoing reflection on how better to prepare educators to adapt and adopt pedagogical frameworks that can support a reimagining of classroom practices and learning environments under duress (Brown et al., 2020; Caldwell, 2020; Egan et al., 2020; OECD, 2020). While previous studies have examined the effect of teacher attitudes toward technology in designing and supporting traditional classrooms through meaningful choice, the conditions of the global pandemic represent wholly different conditions under which there is less scope for choice (Bertram & Pascal, 2021; May & Coulston, 2021).

Montessori constructivist pedagogy provides a specific insight into how such technological conditions and attitudes balance against a pedagogical framework that requires experiential, hands-on learning, and social interaction (Lillard, 2008, 2018, 2019; Phillips-Silver & Daza, 2018; Saylor et al., 2018). While Montessori is certainly not the only such pedagogical framework, its use as a globally recognized educational community allows it to function in defining a specific point of view rather than as a generalized expression based on international and national teacher conditions and attitudes (Ultanir, 2012).

Definition of Terms

Attitude: Attitude is how someone feels about something, often on a spectrum of positive and negative. Attitude, in this case, can also be described as a disposition to like or dislike certain things (Banas, 2010).

Blended learning: Blended learning refers to a learning experience that incorporates both an online and an in-person component. Such a program may feature synchronous or asynchronous lectures and assignments complemented by a residency or internship for hands-on, face-to-face instruction (Duhaney, 2012).

Constructivism: A learning framework that views knowledge as constructed based on experience. Constructivist frameworks value hands-on exploration and experimentation as authentic learning environments. Constructivist frameworks often reject a structured curriculum based on abstract academic skills taught in isolation or repetition (Elkind, 2003).

Distance learning: Distance learning is learning that occurs outside the traditional classroom, but it intends to replicate the classroom environment. Often, distance learning is facilitated by synchronous and asynchronous scheduling over a shared platform or learning management system (Spanjers et al., 2015).

Early childhood: The years of early childhood can range from birth to the beginning of traditional schooling, roughly 5 or 6 years of age, depending on context (O'Keeffe & McNally, 2021).

Face-to-face learning: Face-to-face learning refers to the traditional method of gathering a group of students in one location where they learn together in a synchronous environment. Such a program is rooted in both in-person instruction in terms of a physical classroom as well as in-person application in terms of serving a supervised internship in a physical classroom (McConnell et al., 2013).

Montessori: Pedagogical framework based on the ideas and techniques of Montessori (Montessori, 1912). Montessori is not commercially trademarked or accredited through a specific institution. Various international bodies exist to train and certify Montessori educators, but there is no clear definition of qualifications or reciprocity between institutions. For the purpose of this study, Montessori educators self-identify as Montessori educators and are not required to possess any specific credentials.

Online learning: While online learning can incorporate many types of distance education, for the purpose of this study, online refers to a completely 100% online learning environment without any required residency, internship, and so forth (Spanjers et al., 2015).

Play-based curricula: A play-based curricula focuses on following the natural rhythms of the child and group of children as they build understanding through authentic learning experiences that incorporate the social and emotional aspects of free play (Egan et al., 2020).

Self-efficacy: Self-efficacy is the belief that one is capable of performing some task. For the purposes of this study, self-efficacy is defined as the belief of a teacher that they are capable of performing some task related to their teaching context (Bhatia, 2014).

Teacher identity: The ways in which a teacher identifies themselves as a professional based on a range of personal, professional, and pedagogical frameworks (O. Christensen, 2019).

Technology: For the purpose of this study, technology is defined as the use of systems, programs, platforms, and media for communicating through distance. It does not limit itself to any specific device or software but is focused on the technology that facilitates distance learning (Anderson & Dron, 2012).

Delimitations and Limitations of the Study

While the global pandemic, as the name implies, is a global phenomenon, this particular study is limited in the scope of its inquiry into the experiences of teachers during this moment in time. The study does not seek to endorse any particular program, system, platform, project, or curricula. Instead, it seeks to understand to what extent there is a difference between the method of teacher training and the attitudes and adaptations made by that teacher according to their pedagogical framework during a time of duress. As such, one of the significant limitations of the study is that participants self-identify as Montessori educators and their specific educational credentials will not be verified.

Another significant limitation is the global recruitment of participants. In searching for a relationship between teacher training backgrounds and attitudes toward technology, the emphasis on choosing appropriate participants rests on their self-described teacher training backgrounds, namely online, blended, and face-to-face. Recruiting a group of participants that is equally divided among these three categories might introduce other demographic issues, such as gender, location, and so forth, that might skew the findings. As such, the research study is limited in its ability to draw conclusions on how these issues might affect the results. As Teo and Zhou (2016) noted, there is little evidence that demographic features such as these have a significant effect on

the teacher attitudes and beliefs reflected on quantitative and qualitative survey instruments in regard to technology integration.

In terms of delimitations, the particular biases of the participants could also limit the validity of the findings. The study took place during the spring of 2021, more than a year into the global pandemic, but with no clear end date in place. As such, it is unclear how such a study would apply to other times and under other conditions. The study does not specifically examine teacher emotions about their roles as teachers during a pandemic, but rather their attitudes toward technology and their perspectives on their adaption and adoption of a particular pedagogical framework, namely Montessori. The Montessori approach, widely known for a resistance to technology, serves as a focus point for the balance between a constructivist pedagogical framework and the flexibility to adapt to distance learning. It does not necessarily apply to other pedagogical frameworks, constructivist or otherwise.

Summary

The global pandemic has altered many of the common educational practices of educators all over the world (Atiles et al., 2021; Bertram & Pascal, 2021; OECD, 2020). Much is to be learned from educators facing the shift to distance learning. Many educators face tough choices in how to balance the “new normal” with their pedagogic frameworks of how children learn and thrive (Mantovani et al., 2021; Mochida et al., 2021; O’Keeffe & McNally, 2021). While previous studies have examined the ways that preservice and in-service teachers navigate their attitudes toward technology to build meaningful classroom practices, the conditions of the global pandemic have often eliminated or complicated those choices for educator (Banas, 2010; Byker et al., 2017; Guillen-Gamez & Mayorga-Fernandez, 2020). This study seeks to identify to what extent a difference exists between a teacher’s own training background (online, blended, and

face-to-face) and the attitudes toward technology and flexibility toward adapting and adopting distance learning. The focus of the study rests on Montessori educators, a group known for a commitment to hands-on, experiential learning within a constructivist pedagogical framework (O. Christensen, 2016, 2019; Lillard, 2018; R. R. Setari & Setari, 2018). How Montessori educators balance their pedagogical framework and classroom practices against the requirements of distance learning under duress can provide valuable insights into how teacher training programs can support tomorrow's teachers as well as the ways in which constructivist pedagogies, in particular, respond to challenge.

Chapter 2

Literature Review

This research study examines several broader trends as well as their specific realization within the Montessori pedagogical framework as well as the specific conditions of the global COVID-19 pandemic. A review of the scholarly literature takes into account several important factors in order to provide background and insight into the research context. Four broad themes are the focus of this review of the literature. These include teacher attitudes toward technology, Montessori as a constructivist pedagogy, Montessori attitudes toward technology, and the educational conditions under COVID-19.

In order to explore these four themes in depth, the construction of a theoretical framework based on Vygotsky's (1978) sociocultural theory is necessary in terms of providing a foundation for the research. Delving into the specific considerations of the activity, positioning, and cultural production and practice theories extrapolated from Vygotsky's work, this theoretical framework also forms the basis for the model of teacher identity proposed by Kaplan et al. (2015). This theoretical framework as well as the resulting model of teacher identity serve as the starting point for exploring the ways in which Montessori teacher identity and practitioner attitudes toward technology form and interconnect. This research study relies on the TAT and TAC survey instruments to measure the attitudes of Montessori teachers toward technology. These survey instruments, developed throughout decades at the Institute for the Integration of Technology Into Teaching and Learning at the University of North Texas, reflect the Structural Model of Technology Integration, otherwise known as the Will, Skill, Tool Model of Technology Integration (Knezek & Christensen, 2015; Knezek et al., 2000).

This literature review begins broadly with a review of the available research on general attitudes of educators toward technology and the links between those attitudes and their willingness and ability to integrate technology into their teaching contexts. It then moves on to examine the underpinning constructivism of the Montessori pedagogical framework in order to specify the ways in which Montessori differs from other pedagogical frameworks in order to ground Montessori pedagogy before discussing the ways in which Montessorians view technology. The third section, in turn, combines the Montessori approach with the broader trends of technological implementation in order to articulate many of the concerns of Montessori teacher identity that relate to the use of technology. The fourth section of this literature review examines some of the ongoing responses to the COVID-19 global pandemic relating to the experience of educators. Finally, the literature review examines the ways in which the social media platform of Facebook can be leveraged to gather Montessori voices in order to generate relevant and reliable participants for the survey instruments.

This examination is occurring in real time as the pandemic continues largely unabated in many parts of the world and, therefore, provides a snapshot into the ways that the current situation differs sharply from previous discussions on technology integration in constructivist pedagogical frameworks. This literature review sets the stage for examining the research context from a wide angle in terms of education during a pandemic and from a focused perspective, that of the Montessori educator identity.

Theoretical Framework

Teacher identity and its development is an area of research informed by a variety of related theoretical frameworks (Ahmad et al., 2019). This research study sets itself within the overall framework of Vygotsky's (1978) sociocultural theory. Sociocultural theory serves as a

broad underpinning to the research of this study. Some areas of focus of sociocultural theory that are particularly prescient to this research are activity, positioning, and cultural production and practice.

Activity under sociocultural theory posits that all social actions are goal driven. In the case of teacher identity, the goals of teaching and learning inform the development of teacher identity based on how they achieve their goals. Riyanti (2017) contended that in the third stage of activity, teacher learning becomes a set of interrelated activities for achieving common teaching goals. Part and parcel to this achievement is the reliance on a particular set of tools, methods, and methodologies. In an exploration of Montessori teacher identity, activity provides an understanding of how the core tenets of Montessori and their standard use and interpretation build toward a sense of teacher identity that can be reflected in practitioner attitudes toward technology in the classroom. These attitudes reflect the activity of what tools teachers can use to achieve their teaching goals as defined by their preferred methods and methodology.

Positioning, another element of sociocultural theory, is another aspect particularly relevant to the theoretical framework of this research study. Positioning posits that conversation and dialogue are how learners learn and develop their identities as learners. For teacher learners, the process of teacher identity negotiation is one in which identity is developed against particular constraints. In the general sense, these constraints might be a lack of choice in professional development opportunities that result in a teacher participating against their will (Ahmad et al., 2019). For the purposes of this research study, the conditions of the global pandemic act as a means of negating choice and pushing teachers to act in ways that may be inconsistent with their personal worldviews or outside their normative choices.

A final element of sociocultural theory that informs the theoretical framework for this research study is cultural production and practice. As Varghese (2010) pointed out, in this aspect of sociocultural theory, teachers must balance between a mix of cultural production and conformity to established notions. The Montessori practitioner, in this case, is pulled between the traditional norms of progressive constructivist practice and the new realities of distance learning as a result of the conditions of the pandemic. How this teacher identity development rests on balance between conflicting parameters can be reflected in their attitudes toward technology. Similarly, the shifting push and pull between cultural production and practice provide a relevant lens to view the ways in which Montessori teacher training backgrounds could produce different practitioner attitudes toward technology.

Based on the considerations of sociocultural theory, Kaplan et al. (2015) proposed a teacher identity model. This model is based on four key interrelated components: ontological and epistemological beliefs, purpose and goals, self-perceptions and self-definitions, and perceived action possibilities (Kaplan et al., 2015). This model of teacher identity is one that is particularly relevant to this research study in that it describes the relationship between the beliefs that teachers develop about themselves and their chosen methodologies and the possible actions that they can see themselves performing. The role that teacher training background, be it online, blended, or face-to-face, plays in developing the attitudes that such teachers will bring to their future practice also rests on this connection between beliefs and perceived action possibilities.

The Institute for the Integration of Technology Into Teaching and Learning at the University of North Texas has developed a model for describing the ways in which the background and attitudes of teachers result in their level of technology integration. Building on the foundation of Vygotsky's sociocultural theory, researchers Knezek and Christensen at the

Institute for the Integration of Technology Into Teaching and Learning designed the Structural Model of Technology Integration, otherwise known as the Will, Skill, Tool Model, posited that the combination of the will of a teacher, the skill that they have developed in terms of comfort with technology, and the tools that they have available to them will influence their attitudes toward technology integration (R. Christensen, 2002; Knezek & Christensen, 2015; Petko, 2012; Shattuck et al., 2011). In this case, the will, skill, and tool correspond to the action, position, and production and practice of sociocultural theory. The Will, Skill, Tool Model informs the creation of the TAT and TAC survey instruments that are used within this research study (Knezek & Christensen, 1997, 1998; Knezek et al., 2003; Knezek et al., 2000).

Teacher Attitudes Toward Technology

While the role of technology in the learning environment has evolved over time, the attitudes of educators toward new and emerging technologies have long been fraught with controversy (Elkind, 2016). From the simplest innovations, such as ballpoint pens, to audio-visual resources, the incremental experimentation with new technologies in the classroom has long rested on shifting attitudes among general educators at all levels (Cuban & Jandric, 2015). Reimagining the learning space in terms of new technologies calls into question many of the experiences of both novice and veteran educators, and researchers have long studied the effects of teacher attitudes and beliefs in the integration of technology in the classroom (Banas, 2010; Derbel, 2017; Kimmons et al., 2015). Teachers, as with the population at large, represent those with a personal inclination to be early adopters of technological innovation as well as those who actively resist the inclusion of new technologies in their daily lives (Angeli & Valanides, 2005; Duhaney, 2012; Kim & Seo, 2018; Scherer et al., 2018). Examining how these attitudes play out in the classroom practice of different types of educators is the focus of numerous studies;

however, the attitudes of teachers to technology as a whole are often considered as a starting point in examining the ways that various technologies can facilitate classroom practice (D. Ertmer, 2005; Hughes, 2013; Zeytep et al., 2019).

Often, research in this area begins with a particular technological innovation that researchers want to test in the classroom (Joo et al., 2018; Kim & Seo, 2018). In order to see the technology in context, the research team needs to understand what factors aside from the technology might influence its use and usefulness in the classroom (Sang et al., 2010). Many researchers have determined that the attitudes that teachers have toward technology are some of the most consistent reasons why certain technologies are successfully integrated into classroom practice or whether they remain underutilized or treated as novelties (S. Zhang et al., 2017). In order to encourage broader or more in-depth usage of the technology, the research team must often explicitly address the role that attitudes play in the adoption of new technology (Tondeur et al., 2017). The training in this technological innovation is then accompanied by a parallel study to determine how and why certain teachers make this innovation part of their classroom practice and others do not or do so to a lesser degree (Sibley et al., 2017; Teo & Zhou, 2016).

For the purposes of this study, the particular technological innovation or training is not the focus of research. There is no particular endorsement of one type of technology or a need to prove either its usefulness as a classroom resource or in its acceptability to classroom educators. Instead, this review focuses on the broad trends and themes identified in how teacher beliefs and attitudes relate to the willingness and ability of educators to introduce or maintain technology integration into their classrooms, or as Ottenbreit-Leftwich et al. (2010) proposed, to “examine teacher beliefs without expectations of best practices on teachers” (p. 1321). This extends also to

their own learning backgrounds as preservice or in-service teachers in a professional development context (McConnell et al., 2013).

There are various frameworks proposed for examining teacher attitudes toward technology (Petko, 2012; Scherer et al., 2019). These frameworks have evolved over time in the means and methods of examining teacher attitudes both in the context of specific technological practice and as a general guidepost for analyzing the ways that teacher attitudes and beliefs influence their professional choices (Teo & Zhou, 2016). One of the frameworks that often guides research in this area is the Teacher Attitudes to Information Technology (TAIT) survey instrument that has grown out of various iterations such as the TAC and TAT at the University of North Texas during the 1990s and 2000s (R. Christensen & Knezek, 2009; Knezek & Christensen, 1997). This framework, which has evolved with technology to include Web 2.0 and Web 3.0 applications, examines teacher attitudes outside of any particular technological innovation. This framework allows researchers to examine teacher beliefs and attitudes in order to describe a certain population in broad terms and identify the characteristics that define a particular population (R. Christensen, 2002). The TAIT framework has been used to examine teacher attitude and belief at a range of levels for preservice teachers to veteran teacher leader (Banas, 2010). It highlights teacher strengths as well as anxieties about adopting and adapting new technologies into the classroom (Knezek & Christensen, 2015). Unlike other frameworks that examine teacher attitudes and beliefs, the TAIT is not designed to encourage participants toward adopting any particular technology and is not simply the first step in creating a teacher training program with a specific technological adoption in mind (King & He, 2006). Instead, it examines teacher attitudes and beliefs as an end to themselves, allowing for a more open-ended

method of investigating where teachers are rather than where they can be led (Scherer et al., 2019).

Another framework often used in this context is the Technology, Pedagogy and Content Knowledge (TPACK) model (Joo et al., 2018; Koh et al., 2017). Unlike the TAIT, the TPACK examines the relationship between teacher training and teacher utilization of a specific technology in the classroom (Joo et al., 2018). The end goal is to move participants toward a higher level of technology adoption or to examine the various barriers to technology adoption that cannot be explained by access or training issues alone (Blackwell et al., 2014). The TPACK framework has been utilized in a broad range of contexts, from preservice teachers to teacher-leaders to administrators, with the purpose of documenting the attitude and belief shifts required to adopt a technological practice or innovation into the classroom (Byker et al., 2017). The TPACK framework aligns the often-abstract teacher resistance to technology into the concrete through identifying the practical steps that trainers can use to help teachers process their own learning in order to develop learning backgrounds for their students (D. Ertmer, 2005). While the TAIT framework examines the why behind various teacher attitudes and beliefs, the TPACK framework focuses on the how in terms of connecting teachers with valuable training and professional development backgrounds that will guide them in implementing new technologies in the classroom (Koh et al., 2017).

While the TAIT and the TPACK frameworks have different purposes in how they examine teacher attitudes and beliefs, both have found similar key areas of focus in determining how teacher attitudes and beliefs can create as well as overcome barriers to technology integration in classroom practices (Hughes, 2013). One point of distinction is the way in which teacher attitudes and beliefs influence teacher adoption and adaption of suggested technological

resources as opposed to the ways in which those attitudes and beliefs encourage independent innovation outside of structured training programs (Jenkins et al., 2018; Riyanti, 2017). Researchers utilizing these frameworks have been able to identify some of the broader considerations for how teacher attitudes and beliefs develop and to what extent they can be changed through direct and indirect training, counselling, and learning experiences (Teo & Zhou, 2016). Both the TAIT and TPACK frameworks allow researchers to identify key areas of leverage, or areas where change is possible. Some of the main areas of leverage of teacher attitudes and beliefs include knowledge, confidence or self-efficacy, pedagogical and epistemological beliefs, and contextual and cultural practices (Scherer et al., 2018; Zeytep et al., 2019).

Knowledge is often one of the first areas of interest in examining teacher beliefs about technology (P. A. Ertmer & Ottenbreit-Leftwich, 2010). Teachers come in all shapes and sizes, with different backgrounds that can have profound influence on their ability to see the potential uses of technology for their classroom practice (Tondeur et al., 2017). Technological training and comfort with technology represent a wide spectrum of experience for both veteran and novice educators (Banas, 2010). Knowledge of technology is often the result of personal preferences and choices rather than a standardized training program conducted during preservice or in-service professional development (Duhaney, 2012). It can be difficult to determine the personal comfort level of any particular teacher based solely on their demographic information, as their backgrounds and opportunities contribute a great deal to their ongoing use of technology and openness to innovation (R. Christensen & Knezek, 2009). Similarly, as technology changes over time, the needs of educators for technology for their personal and professional use also changes, resulting in a hodgepodge of knowledge alongside both positive and negative associations with

particular types of technology (Calderhead, 1996). Within the working life of a teacher, technological innovations may come and go, resulting in a range of knowledge and experience that is not necessarily applicable to current conditions or that is reliant on modes of working with technology that remain current in some areas while falling behind the times in others (Byker et al., 2017; Elkind, 2016; Kimmons et al., 2015).

Knowledge, in this context, consists of both the content knowledge of what to teach alongside the pedagogical knowledge of how and why to teach it (Kim & Seo, 2018). Choosing the types of technologies that can best provide meaningful learning experiences for students is then caught in the balance of these two types of knowledge (Angeli & Valanides, 2005). Much of the scholarly literature rests on determining best practices in developing content and pedagogical knowledge. In short, researchers seek to match best practices in the current moment, providing suggestions to teachers that may or may not result in a teacher applying their own innovative ideas or keeping up with what is on the horizon (Teo & Zhou, 2016; Tondeur et al., 2017). As such, the cycle of misalignment between knowledge and application repeats itself (Cuban & Jandric, 2015). However, what many researchers have discovered is that the relationship between these types of knowledge and the creation of meaningful learning experiences rests primarily on another consideration, namely teacher attitudes and beliefs (Derbel, 2017; Ozgur & Bayraktar, 2013; Teo, 2011).

Teacher attitudes and beliefs come in many forms (Guillen-Gamez & Mayorga-Fernandez, 2020). Many are informed by the specific pedagogical frameworks that teachers believe best represent how students learn (Burbank et al., 2020; Culclasure et al., 2019). These beliefs about how students learn and what sorts of experiences facilitate this learning are key to determining how open a teacher is to investigate new and emerging technologies, as the first step

in possible implementation into the classroom (Blackwell et al., 2014). Teacher beliefs are often related to feelings of self-efficacy, or the confidence that an educator has in their abilities as a teacher. A teacher who has strong self-efficacy based on a specific pedagogical framework may have more difficulty in reexamining that framework in light of new technology (Bennetts & Bone, 2019; Chandler et al., 2014). The confidence that they feel in their pedagogical foundations makes them skeptical of how new technologies could undermine their value system (Dansereau & Wyman, 2020). Both novice and veteran teachers alike seek comfort in practices that are familiar to them and in which they have previously experienced success, either as an educator or as a student (Kim & Seo, 2018). Realigning their vision of successful learning with new technologies requires new experiences that reinforce their own sense of self-efficacy as a teacher rather than positioning their backgrounds as oppositional to the inclusion of new ideas (Glass, 2017; Hargis & Hargis, 2020).

A secondary form of self-efficacy relates to technology (Petko, 2012). A teacher who feels confident using technology is more likely to feel a positive association with that technology in the classroom. Joo et al. (2018) recognized that teacher self-efficacy played a greater role in a teacher's intention to use technology than their combined pedagogical and content knowledge. Teachers often see themselves as leaders and models within the classroom, a role that can be detrimental to innovation through the inclusion of new ideas that the teacher is also in the process of mastering (Brown et al., 2020). To take the risk of failure or embarrassment in front of students and colleagues can often serve as a strong barrier to experimentation with new technologies in the classroom (S. Zhang et al., 2017). These two kinds of self-efficacy, similar to the two kinds of knowledge mentioned above, can sometimes work in tandem and sometimes

work against each other in determining an individual's attitude toward technology integration in their classroom (Knezek & Christensen, 2015).

Pedagogical or epistemological beliefs about the nature and processes of learning can be strongly held by teachers (Thomson, 2008). Teachers bring a wide range of personal and professional experiences, abstract theory, and practical application to their classroom practice. Their own educational background as well as their socioeconomic and cultural traditions often result in a strong affinity for the structures of the past as well as a skepticism of how the structures of the future are forming (Kahuroa et al., 2021). Some of these beliefs are the result of personal experience while others are the result of exposure to learning theories through the course of professional training and development (Anderson & Dron, 2012). Examining these beliefs in the context of technology integration can often reveal biases against the use of certain technologies or the lack of understanding of how to apply these beliefs in regard to integrating technology in a meaningful way (D. Ertmer, 2005). One such pedagogical or epistemological belief system is that of Constructivism, often thought of in opposition to Behaviorism (Thomson, 2008; Ultanir, 2012).

Constructivist teaching beliefs, combined with self-efficacy, form a powerful combination in determining prospective technology use (Sang et al., 2010). Part of the disconnect between teacher belief and teacher practice comes as a result of a disconnect between beliefs about the ways that students learn and the ways that teachers teach, leading to "consistent perceptions about obstacles to integration" (Hutchinson & Reinking, 2011, p. 313). Student-centered pedagogy can clash with teacher-centered practices when attempting to integrate technology into the classroom (Hughes, 2013). Teacher attitudes and beliefs must be articulated in order to go beyond a surface understanding of the use of technology in the classroom in order

to avoid superficial application, which in turn leads of negative perceptions of technology's place within theories of how students learn (P. A. Ertmer & Ottenbreit-Leftwich, 2010). As such, "Teacher education programs should consider how they support pre-service teachers to become self-reflective consumers of technology" (Amador et al., 2015, p. 105). In short, the learning backgrounds of teachers, and how they see technology used in the construction of meaning, can help develop a positive attitude or belief in how technology can or should be implemented within the constructivist classroom (Elkind, 2016).

Context and culture represent another significant area of research into how teacher beliefs and attitudes relate to their willingness and ability to integrate technology into their classrooms (Debs & Brown, 2017). From a demographic perspective, there is little evidence that teacher beliefs and attitudes within a given context vary greatly based on factors such as gender, race and ethnicity, and age (Teo & Zhou, 2016). However, teachers with less professional knowledge or less intrinsic interest in identifying uses for technology can be less able to navigate technology integration independently (Hughes, 2005). However, positive teacher beliefs alone are not enough to bridge the gap between theory and practice in integrating technology in a meaningful way (Petko, 2012). There is a strong distinction between being open to suggestion on the specific use of a specific technology and seeking out new and innovative uses of technology on one's own. P. A. Ertmer et al. (2012) referred to a barrier threshold that keeps teachers from overcoming challenges in terms of technological innovation in the classroom despite their best efforts. Contextual and cultural factors might normalize technology use for personal and professional communication without examining the ways in which technology can be a learning tool for students rather than as a passive dissemination tool for teachers (Kimmons et al., 2015). While a clear formula for managing teacher beliefs and expectations has yet to emerge, the

image of the teacher and student grounded in the classroom context is one that has been identified as strengthening teacher voice (Heath, 2017) while reflecting on student voice in creating meaningful learning experiences facilitated by technology.

The relationships among teacher beliefs and attitudes and their use of technology for education reflects the significance of long-held organizational structures over a swiftly developing technological landscape (Knezek & Christensen, 2015; Petko, 2012). As a summary of current research on the topic, Tondeur et al. (2017) reiterated the main themes of the research base in identifying the five key results of a systemic review of the qualitative evidence. These key findings reflect the bidirectional relationship between pedagogical beliefs and technology use, teachers' beliefs as perceived barriers, the association between specific beliefs and types of technology use, the role of beliefs in professional development, and the importance of the school context. These factors continue to influence the experiences of general educators in integration of technology into their educational contexts. By examining teacher attitudes and beliefs within frameworks such as the TAIT and TPACK, researchers are able to identify the main points of leverage where teachers might be open to adopting or adapting technology into their classroom practice (Knezek & Christensen, 1998). Teacher attitudes and beliefs remain the bedrock foundation on which technology integration sits, persisting regardless of training and development opportunities (Scherer et al., 2019). Understanding teacher attitudes and beliefs is a key factor in recognizing both the why and the how of teacher innovation in the classroom (A. P. Setari & Bradley, 2017).

Montessori as a Constructivist Pedagogical Framework

Teacher attitudes and beliefs are the result of many factors, including the pedagogical and epistemological frameworks in which they are trained and in which they practice (Petko, 2012).

Pedagogical frameworks based on constructivist principles rest on a particular understanding of how learning works, the path that child development follows, and the ways in which learning experiences serve as a guide for the expanding world of the child inside and outside the classroom (Lillard & Eisen, 2017). Constructivist ideas have influenced many progressive educational frameworks, including that designed by Montessori in the early 20th century (Lillard, 2018, 2019). Educators trained in the pedagogical framework of the Montessori method reflect a particularly strong interpretation of constructivist pedagogy in opposition to other more traditional or mainstream understandings of how students learn (Saylor et al., 2018). The Montessori method, with its firm footing in the psychological innovations of the last century, presents a particular point of view and point in time in terms of how it interprets pedagogical frameworks based on constructivist frameworks in ways that might not be relevant to the general educator (Lillard & McHughes, 2019a, 2019b). Examining the special characteristics of the Montessori method as a pedagogical framework based on constructivism is essential to understanding some of the underlying principles and practices that inform the professional lives of Montessori educators (O. Christensen, 2019).

Pedagogical frameworks based on constructivist principles (Schunk, 2016) rest on the idea that learners learn through experiences and explorations that allow them to construct their own knowledge. Constructivism places the learner at the center of the learning environment, and rests on the supposition that the learner can and will determine their own learning path if supported by meaningful learning experiences (Dansereau & Wyman, 2020; Lapon, 2020). As opposed to nativism and empiricism, constructivism posits that everyone is capable of learning at a pace that is relative to themselves (Thayer-Bacon, 2017). Constructivism, advocated in various ways by educational reformers and researchers Dewey and Piaget as well as Montessori,

understands learning as a series of stages or planes through which a child develops from concrete to abstract reasoning skills as they learn from the world around them (Ultanir, 2012). Constructivist pedagogical principles posit a revisioning of the ways in which classrooms, schools, and curricula are organized, concentrating less on the following of a set program regardless of the personal developmental progress of the individual (Taggart et al., 2018). The constructivist pedagogical underpinnings of Montessori's exhortation to follow the child, provide insight into the ways that Montessori educators see themselves and their role within the classroom learning environment (Sibley et al., 2017).

Montessori's embrace of constructivist learning principles informed the development of her educational method and approach, providing children with concrete opportunities to develop their individual potential (Elkind, 2003). The prepared environment envisioned by Montessori outlines a series of key constructivist principles that allow the child to explore at their own pace and inclination within a selection of carefully designed and developmentally appropriate experiences (Lillard & McHughes, 2019a). The student-centered curriculum approach, in which individual children learn about the world around them through a targeted program arranged around developing their own independence and self-reliance in the concrete sphere of knowledge has long been a hallmark of the essential Montessori program (Phillips-Silver & Daza, 2018). Hands-on exploratory learning in the real world, with the application of practical life skills in real time and with real purpose, exemplifies the constructivist principles on which Montessori is based (Montessori, 1967, 1972, 1989, 1991). While Montessori put her philosophy in practice within a classroom context, the approach provides a model for personalized learning (Mavric, 2020) within an understanding of how intrinsic motivation allows for greater depth of learning (Murray, 2011).

The pedagogical framework and curriculum designed by Montessori in the beginning of the 20th century spawned a global revolution in the understanding of how children learn and a revision of the traditional teacher-child relationship (Lillard, 2019). While many similar pedagogical frameworks have emerged since, Montessori remains a globally recognized approach built on constructivist principles of active learning. The philosophy behind the Montessori method was articulated by Montessori in a range of books throughout her life, including *The Montessori Method* (Montessori, 1912), *The Absorbent Mind* (Montessori, 1967), *The Discovery of the Child* (Montessori, 1972), *To Educate the Human Potential* (Montessori, 1989), and *Education for a New World* (Montessori, 1991). In each iteration, Montessori exhorts the teacher to provide children with practical learning experiences grounded in the real world, using their physical abilities alongside their cognitive ones. Learning is not something provided by the teacher but is instead something experienced and applied by the learner (Marshall, 2017). In applying the basic principles of constructivism, the Montessori method relies on a range of key features that distinguish it from other educational frameworks, not least of which are the prepared environment and the teacher as guide (Lillard & McHughes, 2019b).

The prepared environment is the foundation of the Montessori approach (Lillard, 2008). A series of materials, referred to as the work of the child, are arranged on low shelves easily accessible to the child (Montessori, 1967). These materials represent a range of developmentally appropriate knowledge challenges across the academic disciplines and within the practical life skills that a child needs to develop to care for themselves and others (Bahmaee et al., 2016). Many of these materials are standard across Montessori environments, while others are designed to reflect the specific needs of the children present in the classroom (Montessori, 1972). The prepared environment, aside from the materials, is also a cultivated atmosphere of peace and

calm, with a conscious attention to clutter, noise, and distractions (Bennetts & Bone, 2019). The prepared environment reflects a considerable amount of dedication on the part of the teachers and students to maintain order and cleanliness in their work environment (Montessori, 1989, 1991).

The most important element of this prepared environment is its versatility and flexibility (Montessori, 1991). Children choose from among the types of work materials available to them, repeating them as many times as necessary to achieve mastery (Taggart et al., 2017). In contrast to many traditional methods and approaches, Montessori allows the child a wide latitude in terms of choice (Monson, 2006). This allows learners to take responsibility for their own learning as well as fulfill their own passions for particular work projects and skills. At the same time Montessori insists on giving time and attention to developing habits of living and learning that reflect the experience of the child regardless of their socioeconomic background (Lillard et al., 2017). Children from a wide range of backgrounds meet on the same plane within the Montessori classroom, entering at their own developmental level and moving within and beyond it rather than marching in unison with a preset curriculum that they might meet, fail to meet, or exceed (Culclasure et al., 2018; Debs & Brown, 2017; Zoll, 2017). Montessori classrooms prepared along this model exist in some sense of uniformity throughout the world, providing a model of a constructivist classroom environment (Monson, 2006; Rathunde, 2001). Relying on a mixture of ages, Montessori classrooms allow space for children to construct their learning on their own timeline, providing developmentally appropriate challenges that meet their learning needs in real time (Lillard, 2018; Monson, 2006).

From the Montessori perspective, the prepared environment is often considered as a teacher in itself (Montessori, 1967, 1972). It offers open-ended opportunities for learning that

children can explore in a leisurely manner that suits the development of their social and emotional as well as academic learning (Fleming et al., 2019). Following constructivist principles, Montessori looks to the whole child, as a collection of thoughts, experiences, and skills that cannot be divided into particular academic skills or held to abstract expectations that do not correspond to a concrete developmental model (Kayili, 2018). The prepared environment is one that is designed with particular care and attention, dedicated to a balance of choices and challenges for students within the classroom to claim as their own (Lillard & McHughes, 2019b). Understanding the materials and how to arrange them in the classroom, how to identify which students are ready for which lessons, and how to support them are all elements of the constructivist pedagogy that informs the work of Montessori educators within the classroom (Jenkins et al., 2018). It creates a particular vision of what a learning space can and should look like, one that is reinforced through Montessori training and practice (Bennetts & Bone, 2019).

The development of the teacher as an individual committed to Montessori core principles is at the heart of Montessori teacher training (O. Christensen, 2019). The teacher, often called a guide in Montessorian parlance, occupies a special role in the classroom. Just as the prepared environment presents itself as a particular kind of teacher, the Montessori guide represents themselves as serving a particular role in the learning journey of the students (Lillard & McHughes, 2019b). The Montessori guide is trained to understand the purpose of all the materials and gauge the developmental appropriateness of them in the work of individual students (O. Christensen, 2019). However, the guide is trained to step back from the traditional teacher role, and instead to follow the lead of the child as the child determines what they need and want to learn (Ivanova, 2014). Montessori philosophy, as such, relies on intrinsic motivation on the parts of individual students to maintain classroom order and determine the course of

lessons (Monson, 2006). For Montessori (1967), “In order to follow the child, the teacher must sublimate her urge to control the child, and seek, instead, to cultivate with meticulous care, the physical and emotional space in which children develop” (p. 253). As such, the Montessori teacher requires a strong grounding in constructivist principles in order to understand the how and why of the prepared classroom environment and to navigate their shifting role among a sea of individual learners (Ultanir, 2012).

The prepared environment and the Montessori guide work in tandem within the constructivist classroom to create a learning experience that can constantly be rearranged and reconfigured to suit the needs of the particular students and their particular learning journeys (Tebano Ahlquist & Gynther, 2020). The constructivist principles that inform the practice of Montessori educators rest firmly on these two considerations being present and available in an open-ended manner, allowing children to make choices and interact among themselves and with both the environment as teacher and the teacher as guide (Oesting, 2018; Ultanir, 2012). The Montessori teacher, then, often considers the prepared environment of the classroom one of the essential aspects of their role as a teacher and an essential component in the planning of learning experiences and lessons for students (Holmes, 2018; Lillard et al., 2017). Considerable attention is put into arranging the space in a way that it supports learner independence and facilitates learner choice (Lillard, 2018). A significant portion of Montessori practical training involves learning to arrange and demonstrate the ways in which the various work materials can be used (Berger, 2016; Branch, 2017). Where textbooks might be a more tangible aspect of the curriculum in a traditional classroom space, the hands-on manipulative materials of the prepared environment define the Montessori experience for many educators and learners (Fraumeni-McBride, 2017).

The relationships between the prepared environment and the Montessori guide are crucial in developing the specific mindset and identity of a Montessori educator (Branch, 2017; Wafford & Rigaud, 2019). The development of the Montessori teacher identity is one that rests on the transformative nature of Montessori teacher training: “For nearly a century, the pedagogical approach known as the Montessori method has placed the cultivation of teachers’ attitudes and values at the center of the process of becoming a teacher” (Whitescarver & Cossentino, 2007, p. 34). During Montessori teacher training, adult teachers study child psychology and development in order to adapt their thinking to that of the child rather than force the child to adapt to the adult’s thinking, as “training the adult into the child’s psychology and knowing his stages of development can lead to a better understanding and discovery of the child” (Barbieru, 2016, p. 108). The Montessori system of teacher training stands as an alternative to traditional teacher training in that it encourages a vitality about culture, craft, and coherence within the system (Cossentino & Whitcomb, 2003). As such, Montessori educators often reflect the need to advocate for “ways of understanding of Montessori’s basic principles and practices in their current relevance” (Loeffler, 2000, p. 26).

The Montessori teacher identity rests on strong constructivist principles, often in opposition to the role prescribed to a teacher within a traditional classroom (Fleming et al., 2019). Part of entering the Montessori system is the entrance to this particular Montessori identity (Burbank et al., 2020). The disposition of the Montessori educator is one that is nurtured and trained into the particular framework of the Montessori method and classroom (Monson, 2006). While this process prepares the Montessori educator to step into the role of guide in the Montessori prepared environment, it also creates a sense of defined concrete mindset in the way that the teacher learns to approach the task of supporting children’s learning and designing

learning experiences (A. E. Jones et al., 2019; Taggart et al., 2018). By developing constructivist principles into the unique Montessori pedagogical framework, Montessori educators develop a systematic mindset and worldview of the nature of childhood and of the developmental processes of learning and thinking (O. Christensen, 2016, 2019). As such, constructivist pedagogy forms a core tenet of the Montessori teaching and learning philosophy, to an extent not seen in other curricula that combine constructivist principles with other behaviorist or cognitivist strategies in various ways (Culclasure et al., 2019; Murray et al., 2019).

Montessori Attitudes Toward the Use of Technology

The special role of the Montessori teacher, or guide, provides a focus point for examining the ways that educator attitudes influence their use of technology (Brown et al., 2020; Powell, 2016). Montessori teachers often have a high level of self-efficacy in terms of their work, with "strong mastery experiences that support their attitudes and desired professional goals" (Bhatia, 2014, p. 46). As such, the Montessori teacher identity is one that is constructed throughout the course of their professional life, but "while a Montessori teacher may have been trained to create and sustain a specific identity, dilemmas create moments for critical examination of, and possible uncertainty about the ability to fulfill such an identity and be a true Montessori teacher" (O. Christensen, 2016, p. 39). The question of what constitutes a true Montessori educator is one that sparks much introspection among Montessori and non-Montessori alike. The particular mindset that is cultivated alongside teacher training and professional development within the Montessori framework speaks to the heightened role that dispositions play in forming the identity of the Montessori teacher, and therefore, framing their attitudes and beliefs about the role that technology can play in their classrooms (R. R. Setari & Setari, 2018).

The Montessori teacher identity, with strong self-efficacy in the paradigm and principles of the Montessori method, has often been cited as a reason why individual Montessori teachers and their larger school contexts choose to eschew technology (O. Christensen, 2019; Powell, 2016). Montessori pedagogy is firmly grounded in the here and now, relying on in-person, hands-on exploratory experiences to understand how the pieces of the world work together (Kirkham & Kidd, 2017). In particular, attention to the need for developing alongside the concrete plane of child development rather than imposing the principles of the abstract stands as one of the cornerstones of the Montessori design of the prepared early childhood environment (Lillard & McHughes, 2019a, 2019b). Montessori "frequently warned against educational methods that bypassed the senses and overwhelmed children with information that has not been filtered to match their developmental characteristics" (Powell, 2016, p. 6). Many Montessori educators take this exhortation to heart in their understanding of the role of the prepared environment and the ways in which technological resources lack the essential characteristics of the concrete plane of child development (Iman et al., 2017; A. E. Jones et al., 2019; Lapon, 2020). As such, Montessori educators often design classroom spaces without including technology, either as a stand-alone activity or incorporated with the various learning materials at hand (Lillard & McHughes, 2019a).

Though simply maintaining a space free of technology might be seen as having a neutralizing effect on the use of technology in the classroom, it often reflects a negative attitude or belief about the presence of technology in the learning environment (S. J. Jones, 2017; MacDonald, 2015; Miranda et al., 2017). As Balague (2018) noted, "Although the Montessori method focused on developing the child's abilities and capabilities…there continues to be much turning of backs on technology" (p. 36). Many teachers actively stand against technology

inclusion, while others are hesitant to introduce any technological variant into the prepared environment (Bennetts & Bone, 2019). Throughout the course of the century in which Montessori developed the work materials that constitute the prepared environment, work materials for a wide range of topics and tools have taken pride of place in Montessori learning environments (Monson, 2006). Choosing to remove or alter some of these materials in the interest of including technological tools is one that calls into question many of the defining constructivist principles of the prepared environment. Miranda et al. (2017) noted a "pedagogical clash" (p. 282) between progressive educational frameworks such as Montessori and the integration of educational technology. While teachers might find technology convenient for their own personal and professional communication, "when it comes to its use as an instructional tool, it is dismissed in favor of the Montessori canon of materials" (Oesting, 2018, para. 4).

While sometimes framed as a debate (M. R. Jones, 2016), the use of technology in the primary and elementary years overshadows the restrictions on the early childhood classrooms, where "you will find a near-absence of the digital" (Hargis & Hargis, 2020, para. 2). The tension between the ubiquitous nature of technological tools in the wider world and the restraint found in the Montessori classroom often reflects the ways in which Montessori educators imagine the learning space and how they provide a supportive environment for children as a refuge from the concerns of the larger world (Iman et al., 2017). For many Montessorians, these restrictions stem from a focus on concrete thinking that is developmentally appropriate to the youngest learners, where "the problem arises when we attempt to replace a valuable hands-on experience with an abstract one too early" (Hargis & Hargis, 2020, p. 92). As such, Montessori educators can be resistant to using digital applications to reinforce the skills that they teach in a hands-on manner. The use of mobile apps to drill math and phonics skills stand as just one of the many ways in

which the Montessori culture of hands-on exploration of three-dimensional manipulatives could potentially be undermined by inclusion in the prepared environment (Saylor et al., 2018; Scott & Glaze, 2017).

Determining what actual Montessori educators believe and experience in regard to technology integration is a difficult task (Brown et al., 2020; O. Christensen, 2016, 2019; Monson, 2006). Many publications and researchers rely on the prevailing worldview that Montessori is a system set apart from the rest of the world of teaching and learning, making it difficult to see how current Montessori educators navigate the various choices available to them in terms of technology integration (Branch, 2017). While many bystanders to the Montessori movement jump to conclusions about the ways in which the Montessori framework can bend to meet the needs of modern technology, others present alternative views on how technology and Montessori philosophy can work together (Hiles, 2018). While the Montessori approach and method have a long-standing tradition of more than a century, there is no official governing body responsible for monitoring and maintaining the specific standards of Montessori (Bennetts & Bone, 2019). Instead, each Montessori educator must find their own way among the various strains of thought in terms of how modern Montessori practice might grow and change (Tebano Ahlquist & Gynther, 2020). The questions that remain are not simply of how Montessori can be adapted to different technological considerations, but why it should or should not do so (Brown et al., 2020; Monson, 2006).

Researchers in various strains of Montessori life, both from the mindset of public policy as well as the narrow focus of one particular Montessori school or classroom, continue to examine these issues with Montessorians on the frontlines (Culclasure et al., 2018; Walls, 2018). The results of these investigations are often more open to technology than might be expected.

While many mainstream Montessori teacher associations caution against the use of digital experiences over hands-on, real-time activities (Powell, 2016), there is growing interest in the ways that Montessori classrooms can include educational technology. Both researchers (Chandler et al., 2014) and practitioners (Berger, 2016; Primary Montessori, 2018) stress the need to reexamine the use of technology in the context of the Montessori classroom, creating a balance between digital and physical manipulatives. For some Montessori educators, the use of technology in the classroom reflects the Montessorian belief that children need to learn to live in the world around them (Powell, 2016). Reflecting on the ubiquity of technology in the greater society and its role in the daily lives of people of all ages, Hubbell (2006) argued that Montessori classes must integrate technology in order to provide learning experiences that are authentic and meaningful in the modern context.

Rather than reject all technology for technology's sake, approaching technology from a Montessori perspective, meaning considering it as a way to connect to the wider world, can be a valid perspective for the modern Montessori educator (O. Christensen, 2016, 2019). Montessori educators often balance the needs of individual learners against the available resources, and some Montessori educators make no distinction among digital and physical resources. Glass (2017) further contended that Montessori pedagogy can be successfully blended with technology in order to ensure that children are prepared to live and interact in the modern world. For many modern Montessori researchers and practitioners, the use of technology in the classroom does not preclude the hands-on nature of the prepared environment but instead acts in a complementary way through reinforcing those skills that can be adequately represented in a digital way (Scott & Glaze, 2017). Montessori educators who are interested in how the world of the classroom and the

world of information technology can interact are not necessarily isolated examples but reflect broader trends toward technology integration as a life skill in a modern society (Holmes, 2018).

Part of the hesitancy on the part of the Montessori educator in regard to using technology is the ability to identify high-quality resources that reinforce the constructivist principles of the Montessori method (Love & Sikorski, 2000; Ultanir, 2012). To this end, they are often met with a wide range of options that may or may not meet their needs. As Rosenburg (2015) noted, "The types of technology early learning classrooms offer their students lack the opportunity for tactile interactivity" (p. 46). The smooth surface of the iPad or keyboard does not offer the same interactions as a physical manipulative or work material. At the same time, many Montessori educators are open to the possibilities of including some technological resources where appropriate for their curriculum and learner needs (Powell, 2016). MacDonald (2015) argued that educational and digital devices that conform to Montessori philosophy can and should be included in the classroom where carefully constructed presentation and considerations for safety ensure that they fit the purpose of the classroom community (Dansereau & Wyman, 2020; Debs & Brown, 2017). While not a wholesale endorsement of technology in the Montessori classroom, carefully chosen appropriate resources may have a place within the constructivist learning space envisioned there (Hiles, 2018).

In addition to finding the right technological tools for the purposes, Powell (n.d.) spoke to the concerns of Montessori teachers, who he posited "harbor a secret fear that if we allow digital toys in the classroom that kids will like those more" (para. 7). However, many Montessori educators express an ambivalence on how to balance care and concern for the purity of Montessori philosophy and method while recognizing that technology "reflects the Montessori philosophy because children need to adapt and be knowledgeable about technology" (Love &

Sikorski, 2000, p. 2). Alongside research into the attitudes of general educators in integrating technology, the attitudes and beliefs that inform the choices of Montessori educators have reflected many similar issues of self-efficacy, beliefs, and contexts (Chandler et al., 2014; Fraumeni-McBride, 2017). As S. J. Jones (2017) noted, while,

> …teachers in this study expressed positive views of technology in general, exhibiting high technology efficacy and valuing the development of technology skills in their students…all struggled to include instructional technology in ways that are consistent with a Montessori paradigm. (p. 17)

The tension remains between the ways in which Montessori educators use technology and the ways that they see it functioning within the classroom space. For many Montessori educators, despite their own personal interest and inclination toward technology, their vision of what a Montessori classroom and learning experience looks like is often shaped by a reliance on the prepared environment of physical manipulatives and work materials (O. Christensen, 2016, 2019; Monson, 2006).

Finding a place for technology in the Montessori classroom often comes down to the same conditions of mindset, teacher identity, and teacher attitudes and beliefs (Kayili, 2018; Kirkham & Kidd, 2017). As with their general educator counterparts, Montessori teachers with technology background and knowledge did not use technology in transformative ways, often citing “low perceived value of these activities in a Montessori classroom” (S. J. Jones, 2017, p. 17). Though they had the knowledge, and possibly also the interest, in using technology to support their learning environment, Montessori teachers, when asked to relate directly technology to their lived experience as Montessori educators, found it difficult to ground their use of technology in the constructivist principles of the Montessori method (Brown et al., 2020;

S. J. Jones, 2017). Byker et al. (2017) noted the same tension between teacher belief and practice in which,

> …although the teacher candidates had learner-centered definitions of Student Voice, it was difficult for them to translate their definitions into actual lesson plan ideas that included the integration of educational technology in order for students to create so that their voices could be heard. (p. 123)

For many Montessori educators, the division between the physical and digital space is too strict to be overcome. This barrier to technology adoption and adaptation often comes down to the Montessori teacher identity and its prevailing values in maintaining a strict adherence to a tried and tested method (O. Christensen, 2016, 2019; Lillard, 2019).

Educational Conditions Under COVID-19

Montessori educators, along with all educators as well as the general population, find themselves confronted with a fundamental shift in learning opportunities as a result of the ongoing COVID-19 global pandemic (Kahuroa et al., 2021). Though the process varied throughout the world, beginning in March of 2020, and continuing through the present day, the effects of the global pandemic on the school and learning experiences of children around the world has largely changed in ways unimaginable in the past (Barnett et al., 2021; Campos & Vieira, 2021; Mantovani et al., 2021). For many Montessori educators, confronted with these conditions, the transition from the physical to the digital environment moved from a theoretical quagmire to their daily reality (Brown et al., 2020). The strains of this transition can be felt across society, particularly in the lives of educators and students, and results in pedagogical implications that researchers are just beginning to confront and examine (Mitchell et al., 2020; OECD, 2020). The place of the Montessori method and the constructivist principles it represents

is one that bears witness to the changing landscape and mounting challenges of providing high-quality and developmentally appropriate learning experiences for children under extreme conditions (Bennetts & Bone, 2020; Tebano Ahlquist & Gynther, 2020).

> In her literature review of Montessori teacher identity, O. Christensen (2019) noted:
>
> Early Childhood Montessori teachers today need to be prepared for challenges that may not have been directly addressed in their Montessori transformation and at times may require teaching skills and strategies that differ from or even contradict Dr. Montessori's original directions. (p. 54)

This statement serves as a prediction for the situation that Montessori educators and educators in general around the world find themselves facing during the COVID-19 pandemic. While the integration of technology into educational contexts has long been studied in terms of teacher attitudes and beliefs as well as best practices (Darling-Hammond et al., 2020), the educational context of the COVID-19 pandemic is different in many significant ways, the first and foremost of which is the issue of choice (Bertram & Pascal, 2021; May & Coulston, 2021). While many of the studies cited both with general educators and Montessori educators suggested ways to bolster technology integration and understand the barriers to doing so, the COVID-19 pandemic has largely removed much of the debate within the practical considerations of widespread distance learning and closed face-to-face classes (Brown et al., 2020). Instead of discussing the challenges of integrating specific technology platforms and devices within a classroom context, including training for teachers, students, and parents, educators found themselves reconstructing the learning environment from scratch with many choices mandated from outside the classroom (Atiles et al., 2021; Formosinho, 2021; Mantovani et al., 2021).

For educators all over the world, “The pandemic provided a vital opportunity for early years’ researchers, educators, and policy makers to consider how their methodologies, pedagogic philosophy, pedagogic approaches and policies might adapt and respond to children’s particular needs” (Bertram & Pascal, 2021, p. 2). May and Coulston (2021) further discussed the ways in which the pandemic has challenged established pedagogical frameworks and forced organizations large and small to adapt quickly. Montessori teachers, schools, and researchers find themselves in the position of justifying any further ambivalence with technology against the backdrop of large-scale societal needs and demands (Brown et al., 2020). Rather than discussing theoretical best practices and cultivating a constructivist mindset in the classroom, Montessori educators find themselves without a clear pathway and without the ability to fall back on the pedagogical framework represented by the prepared environment of the Montessori classroom (Hargis & Hargis, 2020). For many Montessori educators, the adjustment of the prepared environment and the shift in the interactive nature of whole class and individualized instruction is one fraught with challenges that do not easily resolve in favor of the tried and trusted Montessori approach and method (Jenkins et al., 2018). How to adapt and how to align within the Montessori constructivist pedagogical framework remain the questions confronted by Montessori educators all over the world (Brown et al., 2020).

While the pandemic is an ongoing phenomenon, researchers have already begun to gather insight into how educators have responded to the challenge and what supports they further require. Atiles et al. (2021) explored these issues in order to identify some of the key factors. Their major findings included an emphasis on the teacher training backgrounds of the teachers, noting that most technology training were “limited to specific platforms to teach online…none were trained to effectively engage in online or distance education with young children” (p. 9). In

addition, participants expressed serious challenges in meeting their educational goals for their students and providing quality educational experiences. Based on these factors, Atiles et al. (2021) recommended that the focus on teacher training and development needed to include the "knowledge, skills and dispositions necessary to successfully reconsider and participate in distance teaching and learning" (p. 11).

For Montessorians specifically, the conditions of the pandemic have brought up pedagogical and epistemological questions that are not easily answered. Caldwell (2020) asked, "how to keep our schools going when we cannot possibly adhere to fundamental tenets that distinguish Montessori education from conventional schooling?" (para. 3). Falling back on the idea that the Montessori paradigm is fundamentally in conflict with the integration of technology, Caldwell (2020) went on to state, "All of a sudden we are faced with a situation that demands that we operate in an environment that we have avoided or even renounced" (para. 3). For many Montessori educators, the perceived conflict between Montessori and the wider educational world became a real conflict in terms of how to adapt the Montessori classroom under the conditions necessary as a result of the pandemic (Brown et al., 2020). Many Montessori teachers struggled to adapt the student-centered nature of the Montessori learning experience and the constructivist mindset inculcated in the Montessori teacher identity during the transition to the digital learning environment (O. Christensen, 2019; Culclasure et al., 2019).

The National Center for Montessori in the Public Sector, the Center for Montessori Research at the University of Kansas, and the University of Buffalo teamed up to conduct a survey of Montessori educators facing the pandemic, revealing many of the same concerns of teacher identity amid the supposition that "Montessorians generally have a reputation for ambivalence toward technology" (Brown et al., 2020, p. 6). In their preliminary findings, they

found that 36% of respondents rated their own performance during this time as “Not Well,” and 50% of respondents rated their performance as “Moderately Well.” Research on this front has only begun to ask the question: “How could one begin to think about Montessori teaching and learning outside of the context of the prepared environment of the classroom?” (Brown et al., 2020, p. 4). As the pandemic marks its 1-year anniversary, these questions are no closer to being answered and research remains at the preliminary stages in terms of determining which aspects of progressive educational frameworks such as Montessori can be adapted and reimagined under the conditions under which they find themselves.

Montessori Voices on Facebook

As the research on the adaptation of Montessori pedagogy in a digital environment is a new and ongoing concern, building a base of Montessori educators in order to explore these issues is one of the fundamental aims in developing this line of inquiry. How to tap into the wide experience and understanding of Montessori educators who are working toward resolving these issues in real time is a complex and multifaceted process (Brown et al., 2020). While the theoretical underpinnings of understanding teacher attitudes and beliefs and their effect on the ways in which teachers use technology in their classroom practice has developed a strong foundation in terms of the TAIT and TPACK frameworks, the situation of the current pandemic contributes fundamental differences from the established research base (Angeli & Valanides, 2005; Joo et al., 2018; Koh et al., 2017). On the one hand, the language of choice has all but been eliminated as teachers navigate between the lesser of various pedagogical evils. On the other hand, the intrinsic need and motivation in adopting and adapting technology to the Montessori classroom changes many of the practical considerations of Montessori educators working under current conditions (Bennetts & Bone, 2020).

In order to take a snapshot of the moment, gaining access to Montessori educators who are currently practicing in the field is imperative. In order to do so, social media platforms such as Facebook offer a window into the lived experience of Montessori educators facing the challenges of the global pandemic (Kalameri et al., 2020; Salgani, 2017). Leveraging the global nature of the social media platform, researchers can access a wide pool of interested parties (Baek et al., 2011). While social media as a tool for research is a relatively new phenomenon, there is a growing research base for determining when and how to use Facebook as a data resource (Ferucci, 2015). For a research study such as this one, the ability to connect to Montessori interest groups and identify potential participants is one that takes into account both ethical and practical concerns (Willis, 2019). By inviting participants to take part in the survey instruments, researchers can both preserve their anonymity and privacy while gathering a wide swathe of demographic information that is both targeted in purpose and narrow in scope (Gosling et al., 2004).

Research into the viability of Facebook data stresses two main points: ethical considerations and practical considerations (Jiang et al., 2020). From an ethical standpoint, the availability of Facebook user data can be a potential minefield for researchers, as no informed consent is offered to users when data are mined in this way (Henrich et al., 2010). However, for the purposes of this research study, only targeted users in relevant groups were invited to participate. These users had the opportunity to give informed consent and their personal data on Facebook were not available for the research. Instead, the participants were able to control the information given to the research study (Hargittai, 2007). From a practical point of view, Facebook groups offer an opportunity to target specific relevant participants rather than open the research to the general public, which may or may not have an intrinsic motivation in responding

to the invitation (Ahmed et al., 2018; Baran & Ghaffari, 2017). Research on Facebook has shown that when used in a targeted fashion toward parties with a personal motivation for participation, the social media platform can be a valuable tool in reaching the right participants for the study (Kosinski et al., 2015; Ross et al., 2009; Solberg, 2010).

Summary

The COVID-19 global pandemic, while still ongoing, offers an opportunity to examine the ways in which constructivist progressive pedagogical frameworks such as Montessori can adapt to distance learning conditions that contradict much of the traditional classroom and identity of its educators. While researchers have long examined the ways in which teacher attitudes and beliefs relate to their acceptance and integration of technology, the focus has often been on navigating educator choice as a part of a meaningful and thought-out approach aligned with technological professional development opportunities. Two frameworks for examining teacher attitudes and beliefs, the TAIT and TPACK provide instruments for examining the ways in which teacher attitudes and beliefs influence the willingness and ability to adopt and adapt technology in the classroom.

The conditions of the global pandemic differ sharply from the conditions of choice as educators shift in real time and often under conditions of duress. Montessori educators, particularly at the level of early childhood, face challenges both in the shift of learning environment as well as within the transformative teacher identity created through Montessori teacher training. This study examines the ways in which those Montessori educators' own teacher training backgrounds may relate to their acceptance of technology as part of a Montessori classroom experience as well as how the particular Montessori teacher identity can adapt under the conditions of the COVID-19 pandemic. In order to take a snapshot in time, the research

utilized the research potential of the social media platform Facebook in gathering relevant Montessori voices to lend their perspective on the issue.

Chapter 3

Methodology

In seeking to examine the differences between the attitudes toward technology of Montessori teachers from different training backgrounds, there are many different avenues for explorations (Creswell & Creswell, 2020; Doldor et al., 2017). Qualitative research creates a detailed picture of the phenomenon under study (Creswell & Poth, 2018), utilizing the methods of historical, ethnographic, case study, and narrative. Qualitative research uses an inductive approach in which researchers extract broad themes and interpretive analysis (Pernecky, 2016). In qualitative research, researchers seek to understand the broader picture of a particular experience among individuals or groups (Rosenthal, 2018). Quantitative research, on the other hand, acts more as a snapshot in time and space, pinpointing specific data related to the phenomenon under study (Hoy, 2016). For the purposes of this research study, a quantitative approach was chosen in order to gain a snapshot of the conditions of Montessori educators during a specific period of time, namely the COVID-19 pandemic, and examine what differences the training backgrounds of these educators might cause in their attitudes to technology integration in the classroom.

In terms of quantitative research, there are various methods for conducting research and producing data: descriptive, correlational, causal-comparative or quasi-experimental, and experimental (Creswell & Creswell, 2020; Hoy, 2016). Of these deductive research methods, descriptive research provides an opportunity to capture the moment without seeking a correlational relationship or causal comparison between variables (Goertzen, 2017). While a correlational study would look for relationships between variables, an experimental study would test out the possible effects of a change in some aspect of the target population's normal

functioning (Kerlinger, 1986). Rather than conduct and experiment, this research study is based on ex post facto research, or a "systemic empirical inquiry in which the researcher does not have direct control of the independent variable because the variable has already occurred" (Hoy, 2016, p. 42). This research study employs a causal comparative quantitative research design in that it seeks to compare the groups that focus on the independent variables of the teacher training background (online, blended, and face-to-face) with the dependent variable of the score that that teacher receives on a survey instrument on TAT and TAC.

As a causal comparative study, this research examines the possible difference between the type of teacher training background of a Montessori educator and their attitude to technology during distance learning under the conditions of the COVID-19 pandemic. In this causal-comparative research, the variables are identified but not manipulated. Instead, they represent preexisting groups (Goertzen, 2017). The research design consists of a quantitative survey instrument based on the TAT and TAC survey instruments (R. Christensen & Knezek, 2009). Permission to use the survey was granted by the chief researcher, Dr. Rhonda Christensen (see Appendix A). Participants were self-identified Montessori educators from around the globe who connected through Montessori-related Facebook groups.

Research Design

This research study employs a causal comparative research design to compare the type of teacher training background (online, blended, and face-to-face) of a Montessori educator and the attitudes of that educator during the shift to distance learning as a result of the COVID-19 pandemic. These educator backgrounds (online, blended, and face-to-face) are the independent variables. The quantitative survey instrument collected both demographic information and information about general attitudes toward technology in education. The demographic

information serves as an important tool for identifying possible gaps or biases in the participant pool that are tangential to the purpose of the research study. The quantitative survey is based on the established survey instruments, the TAT and the TAC, developed and validated during previous decades by the Institute for the Integration of Technology in Teaching and Learning at the University of North Texas (R. Christensen & Knezek, 2009; Knezek & Christensen, 2015). Scores on each of the subscales of this instrument are the dependent variables of this research.

Research Objectives

The main question asked in this research study is how the conditions of a teacher's individual training, be it online, blended, or face-to-face, influence their attitudes to adapting the specific constructivist Montessori pedagogical framework to distance learning, assumed under duress, during the COVID-19 pandemic. The study examines the backgrounds of self-identified Montessori educators to determine what difference, if any, might exist between the type of training that they received and their willingness and ability to adapt under novel distance learning conditions under the COVID-19 pandemic. Through the use of a quantitative survey instrument, the research hopes to identify how the teacher training background of educators might influence their attitudes and practices during a specific snapshot in time.

This quantitative causal comparative study compares the attitudes of Montessori teachers from different training backgrounds in order to determine if these training backgrounds result in different attitudes toward technology in the classroom. The independent variables are nominal in that they refer to the three types of teacher training, namely online, blended, and face-to-face, independent of each other (Laerd Statistics, n.d.). The dependent variables are the scores on each subset of the TAC and TAT survey instruments that measure teacher attitudes toward the use of technology. These scores consist of ordinal variables such as the Likert scale (Laerd Statistics,

n.d.). The null hypotheses tested are the correlations between the type of teacher training program (online, blended, or face-to-face) and the scores on the TAT survey. These is also cross-referenced for correlations based on the demographic information collected on each participant in order to eliminate any tangential correlations based on these factors.

The research question it seeks to clarify is:

RQ: Are there differences in attitudes to the integration of technology as measured on the TAC/TAT among teachers of three training backgrounds: online, blended, and face-to-face?

$H1_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

H1: There is a difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

$H2_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

H2: There is a difference on one or more subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

$H3_0$: There is no difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

H3: There is a difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

Quantitative Instrument

Teacher attitudes to technology are an important area of research and have been explored in many ways through many iterations of technological progress in education. While instruments such as the Teacher Acceptance Model (Scherer et al., 2019; Zeytep et al., 2019) and the TPACK

(Koh et al., 2017) exist to measure teacher attitudes toward technology, they are often in tandem with a specific educational technology professional development training experience (King & He, 2006; Scherer et al., 2018). As this research study is not interested in determining best practices, the TAT and its previous iteration, the TAC, survey instruments are more applicable. Both the TAT and TAC are designed to provide an overview of attitudes and preferences in a minimum of time. These survey instruments have been evaluated for internal consistency reliability (Knezek & Christensen, 1997) and construct validity (R. Christensen & Knezek, 2009).

A survey instrument was designed using the TAT and TAC as a basis (see Table 1). The basic format of the TAT is utilized with minor alterations to the introductory demographic information in which the specific choices of online, blended, and face-to-face training are added. Permission to use the survey instrument was granted by the principal researchers, Dr. Rhonda Christensen (see Appendix A). The survey consists of nine subscales. The first eight subsections refer to key components of teacher attitudes toward technology, including interest, comfort, accommodation, interaction, concern, utility, absorption, and significance. The ninth subsection uses the Stages of Technology Adoption scale for participants to self-assess their current stage of technology adoption. See Appendix B for the full survey.

Table 1

An Overview of Survey Instrument

Survey part	Number of items	Format
Demographic Information	10	Multiple choice

(continued)

Survey part	Number of items	Format
Part 1: Interest	12	Likert scale
Part 2: Comfort	10	Likert scale
Part 3: Accommodation	11	Likert scale
Part 4: Interaction	10	Likert scale
Part 5: Concern	11	Likert scale
Part 6: Utility	10	Likert scale
Part 7: Absorption	10	Likert scale
Part 8: Significance	14	Likert scale
Part 9: Stages of Technology Adoption Scale	1	Multiple choice

Reliability and Validity of Survey Instrument

Ethical considerations for this study include survey instrument validity as well as the protection of participants in terms of safety and confidentiality. The survey instrument is based on an established, well-validated survey instrument from the University of North Texas. This survey as well as its related scoring criteria have been validated across a range of education contexts (R. Christensen & Knezek, 2009). The only modifications to this survey are the inclusion of information specific to the Montessori teacher training background, such as type of teacher training background in terms of online, blended, or face-to-face.

R. Christensen and Knezek (2009), the original developers of the TAC and TAT survey instruments, conducted a construct validity study of the instrument. The survey instrument was

developed throughout several decades with many iterations. In the first internal consistency reliability for Seven-Factor structure of the TAC, see Table 2 (R. Christensen & Knezek, 2009).

Table 2

Seven-Factor Structure of the Teacher Attitude to Computers

Factor	α	Number of items
F1 (enthusiasm/enjoyment)	.98	30
F2 (anxiety)	.98	30
F3 (avoidance/acceptance)	.90	13
F4 (email for classroom learning)	.95	11
F5 (negative impact on society)	.85	11
F6 (productivity)	.96	30
F7 (semantic perception of computers)	.94	10

Note. Adapted from "Construct Validity for the Teachers' Attitudes Towards Computers Questionnaire," by R. W. Christensen and G. A. Knezek, 2009, *Journal of Computing in Teacher Education*, *25*(4), p. 144 (https://doi.org/10.1080/10402454.2009.10784623). Copyright 2009 by Copyright Holder. Adapted with permission.

The researchers then examined the reliability increments as a result of increasing numbers of items for each of the seven subscales, resulting in the data in Table 3 (R. Christensen & Knezek, 2009). See Appendix A for permission for use.

Table 3

Reliability Increments of Teacher Attitude to Computers Subscales

Subscale	Items										
	5	6	7	8	9	10	11	12	13	14	15
F1 (Enjoyment)	.91	.91	.92	.93	.93	.94	.95	.94	.94	.95	.95
F2 (Anxiety)	.92	.92	.93	.92	.93	.94	.95	.95	.95	.95	.95
F3 (Avoidance)	.80	.80	.82	.84	.86	.87	.88	.88	.89		
F4 (Email)	.96	.95	.95	.95	.96	.95	.95				
F5 (Negative Impact)	.83	.83	.84	.85	.85	.86	.87				
F6 (Productivity)	.87	.87	.88	.90	.91	.91	.92	.92	.93	.93	.93
F7 (Semantic Perception)	.92	.93	.93	.94	.94	.94					

Note. Adapted from "Construct Validity for the Teachers' Attitudes Towards Computers Questionnaire," by R. W. Christensen and G. A. Knezek, 2009, *Journal of Computing in Teacher Education*, *25*(4), p. 145 (https://doi.org/10.1080/10402454.2009.10784623). Copyright 2009 by Copyright Holder. Adapted with permission.

As part of the refinement process, the TAC was administered in Texan schools in 1995–1997 and 1998–1999, resulting in the data in Table 4 (R. Christensen & Knezek, 2009). See Appendix A for permissions for use.

Table 4

Teacher Attitude to Computers Refinement Data

Scale/part	No. items	Standard item codes	α in Texas 1995–1999*	α in Texas 1998–1999**
Interest	9	186, 103, 211, 180, 181, 10, 9, 12, 4	.88	.90
Comfort	8	263, 230, 17, 227, 18, 15, 20, 13	.94	.92
Accommodation	11	150, 192, 74, 154, 123, 164, 257, 292	.86	.86
Interaction (email)	10	282, 284, 281, 283, 280, 276, 278, 279	.95	.95
Concern	10	142, 215, 138, 135, 144, 176, 134, 241, 277, 274, 251, 218	.84	.86
Utility	10	202, 204, 226, 175, 207, 163, 168, 162, 170, 149	.89	.92
Perception	7	44, 50, 49, 41, 46, 43, 42	.92	.93
Absorption	10	98, 193, 85, 100, 57, 69, 99, 60, 54, 104	.89	.88

(continued)

Scale/part	No. items	Standard item codes	α in Texas 1995–1999*	α in Texas 1998–1999**
Significance	10	96, 95, 172, 97, 199, 198, 214, 62, 216, 173	.84	.86
Total	85			

Note. Adapted from "Construct Validity for the Teachers' Attitudes Towards Computers Questionnaire," by R. W. Christensen and G. A. Knezek, 2009, *Journal of Computing in Teacher Education*, *25*(4), p. 148 (https://doi.org/10.1080/10402454.2009.10784623). Copyright 2009 by Copyright Holder. Adapted with permission.

* *N* = 621. ** *N* = 1,296.

The TAC was further refined in April 2000 (see Table 5), including versions in both English and Spanish (R. Christensen & Knezek, 2009). See Appendix A for permission for use.

Table 5

Reliability Estimates for Teacher Attitude to Computers Version 6 Subscales Based on April 2000 Teacher Data

Part	No. items	Standard item codes	α for Texas 2000
Interest	5	186, 103, 211, 181, 10	.90
Comfort	5	263, 230, 17, 227, 18	.94
Accommodation	5	150, 192, 74, 154, 123	.88
Interaction (email)	5	282, 284, 281, 283, 280	.94

(continued)

Part	No. items	Standard item codes	α for Texas 2000
Concern	8	142, 215, 138, 135, 144, 176, 134, 241	.89
Utility	8	202, 204, 226, 175, 207, 163, 168, 162	.90
Perception	5	44, 50, 49, 41, 46	.96
Absorption	5	98, 193, 85, 100, 69	.89
Significance	5	96, 95, 172, 97, 199	.84
Total	51		

Note. Adapted from "Construct Validity for the Teachers' Attitudes Towards Computers Questionnaire," by R. W. Christensen and G. A. Knezek, 2009, *Journal of Computing in Teacher Education*, *25*(4), p. 150 (https://doi.org/10.1080/10402454.2009.10784623). Copyright 2009 by Copyright Holder. Adapted with permission. *N* = 546.

Reliability of the TAT and TAC based on the confirmative factor analysis was conducted by Shattuck et al. (2011). This confirmative factor analysis (see Table 6) compared reliability results across three large-scale administrations of the TAT and TAC (Shattuck et al., 2011). See Appendix C for permission for use.

Table 6

Item Correlations and Internal Reliabilities for the 13- and 11-Factor Versions of the Teacher Attitude to Computers/Teacher Attitudes Towards Technology Reduced: North Carolina and Texas/Nevada Data

	Item correlation (α)	
Factor	North Carolina	Texas/Nevada
Interest	(.84)	(.88)
1-3	.63	.66
1-8	.43	.43
8-1	.67	.73
8-2	.72	.77
8-3	.66	.74
8-5	.58	.62
8-6	.54	.67
Comfort	(.92)	(.93)
2-1	.82	.85
2-2	.88	.89
2-3	.81	.83
Interaction electronic	(.94)	(.95)
4-2	.83	.85
4-3	.90	.91
4-4	.87	.90

(continued)

Factor	Item correlation (α)	
	North Carolina	Texas/Nevada
4-5	.85	.87
Concern	(.85)	(.86)
5-3	.69	.71
5-4	.68	.68
5-5	.73	.75
5-6	.64	.64
5-7	.58	.62
Utility	(.86)	(.88)
6-2	.72	.78
6-3	.74	.76
6-4	.76	.79
6-7	.60	.63
Perceptions	(.94)	(.95)
7-2	.84	.89
7-3	.84	.87
7-4	.90	.88
7-7	.95	.85
Electronic mail	(.91)	(.89)
TAT1-4	.81	.78
TAT1-6	.82	.75

(continued)

Factor	Item correlation (α)	
	North Carolina	Texas/Nevada
TAT1-7	.83	.81
World Wide Web	(.94)	(.92)
TAT2-4	.87	.82
TAT2-6	.89	.82
TAT2-7	.89	.86
Multimedia (teachers)	(.94)	(.95)
TAT3-4	.87	.86
TAT3-6	.87	.89
TAT3-7	.90	.90
Productivity (teachers)	(.94)	(.91)
TAT4-4	.78	.85
TAT4-6	.76	.78
TAT4-7	.83	.84
Productivity (students)	(.94)	(.92)
TAT5-4	.83	.83
TAT5-6	.90	.84
TAT5-7	.89	.87

Note. Adapted from "Measuring Teacher Attitudes Towards Instructional Technology: A Confirmatory Factor Analysis of the TAC and TAT," by D. Shattuck, K. A. Corbell, J. W. Osbourne, G. Knezek, R. Christensen, and L. Grable, 2011, *Computers in Schools*, *28*(4), p. 305 (https://doi.org/10.1080/07380569.2011.621830). Copyright 2011. Adapted with permission.

Population

This study does not seek to propose or validate a specific set of best practices. Instead, it intends to capture a snapshot of the attitudes and beliefs of Montessori educators and determine if any relationship exists between the teacher training backgrounds of Montessori educators and their willingness and ability to adapt the Montessori paradigm to the distance learning conditions under the COVID-19 pandemic. As such, the population of potential participants includes all Montessori educators across the globe. The defining characteristic of this group is self-identification as a Montessori educator. As Gosling et al. (2004) determined:

> Internet samples are shown to be relatively diverse with respect to gender, socioeconomic status, geographic reason, and age. Internet findings generalize across presentation formats and are not adversely affected by nonserious or repeat responders and are consistent with findings from traditional methods. (p. 93)

Targeting such a broad population goes beyond examining the characteristics of one school, one organizational pool, or even one country (Sue & Ritter, 2012). However, a purposive sampling of participants from targeted Facebook posts within Montessori-specific Facebook groups can help to filter out irrelevant responses (Fenner & Piotrowski, 2017; Kalameri et al., 2020). The use of Facebook as a platform for gathering a population sample rests on a developing scholarly research base. As Kosinski et al. (2015) concluded: “Using Facebook in research is often relatively straightforward and generally produces robust results” (p. 4). In addition, recruiting volunteers using targeted Facebook posts,

> …provide[s] an inexpensive and relatively high-quality alternative…additionally the size and diversity of the Facebook population help[s] to minimize the disadvantages of snowball sampling…employing virality based on an intrinsic motivation means that

> people share and participate in a study out of personal interest rather than financial gain, which is thus likely to yield better data of higher quality. (Kosinski et al., 2015, p. 9)

Participants

Participants were drawn through the use of targeted posts in Montessori-specific Facebook groups. The groups in Table 7 were utilized in the initial stages of the research, though the survey was also able to be shared virally over the social media platform.

Table 7

Montessori-Specific Facebook Groups for Posts Recruiting Participants

Facebook group	Number of members
Montessori Administrators	2,800
Montessori Elementary Teachers & Assistants	6,800
Montessori Educators	12,300
AMI Montessori Discussion	12,400
Association of Montessori Afrika	493
Demystifying Cosmic Education	839
Global Montessori	4,600
Lead Montessori	1,400
Montessori 2.0	24,500
Montessori and Special Needs	2,700

(continued)

Facebook group	Number of members
Montessori Creatives	6,000
Montessori Europe	2,700
Montessori Events All Over the World	2,100
Montessori Leadership	3,800
Montessori Learning	832
Montessori Movement Unites	405
Montessori Noticeboard	1,800
Montessori Philosophy	3,800
Montessori School Teachers	839
Montessori Thrive	849
Montessori Voices	1,100
Montessori Worldwide	3,700
Global Montessori Network	4,000

Sample

Based on the demographic information provided by the participants recruited from the targeted Facebook posts, the survey aimed for a minimum of 100 respondents based on the Gpower calculations (Faul et al., 2009). This is based on the use of a one-way ANOVA used to test the relationships among three groups (J. Zhang & Liang, 2014). The sample size was determined for both *F* tests and *t*-tests. For *F* tests, the parameters of an effect size f of 0.25 and a

power (1- β err prob) of 0.95 resulted in a total sample size of 100. For *t*-tests, the parameters of effect size of 0.3 and a power (1- β err prob) of 0.95 also resulted in a total sample size of 100. Because the focus of this research study is on the teacher training backgrounds of Montessori educators, priority recruitment focuses on participants from all three teacher training formats: online, blended, and face-to-face. Recruiting a sample balanced among the three formats take precedence over other demographic considerations. In order to anticipate the need for attrition in terms of the statistical data, an additional 20% of the sample was recruited, resulting in a minimum of 120 participants. In order to account further for attrition among the three teacher backgrounds, the initial sample size was least 200, with an $n = 50$ from each group.

Data Collection Procedures

The process of collecting responses to the survey instrument took place during autumn of 2021. The method of data collection was targeted postings within Montessori-specific Facebook groups. The survey was designed using Qualtrics analytic software and shared via targeted postings on Montessori-specific Facebook groups. During the initial survey period, responses were collected and aggregated according to the demographic information. Surveys were collected until the minimum of 200 responses was collected. These responses were aggregated according to the teacher training background information (blended, online, and face-to-face) to identify gaps in responses. The survey required a minimum of $n = 50$ for each group, according to the G power calculation above. Demographic information was also examined for variance to insure to identify any tangential relationships unconnected with the research questions (Sue & Ritter, 2012).

The quantitative instrument responses were analyzed for differences between the teacher training background and the attitudes according to the scoring criteria for the TAT and TAC

scoring criteria as outlined in R. Christensen and Knezek (2009). Determining if there is a difference among each type of teacher training and the attitudes of teachers who attended that training is the first step in identifying if there is a stronger connection between one type of teacher training background comparative to the others. A comparison of scores across the three types of teacher training backgrounds can provide confirmation or rejection of the hypotheses related to each research question.

Data Analysis Plan

An exploratory analysis of data was conducted with descriptive statistics for each group (online, blended, and face-to-face). Next a *t*-test for the difference between two sample means was conducted. The three teacher groups were compared in each of the 10 subscales of the TAC/TAT survey instrument with a separate *t*-test for each comparison. The data were examined to accept or fail to reject the null hypothesis for each category. Performing separate *t*-tests provided more opportunities for finding a significant difference between groups by comparing the groups on a number of variables (Gall et al., 2007). However, performing multiple *t*-tests increases the likelihood of Type 1 error (Laerd Statistics, n.d.). A Type 1 error is a false positive, in which a null hypothesis is rejected because of chance rather than a real significance.

In order to reduce the possibility of a Type 1 error, a one-way ANOVA was conducted. Descriptive statistics were used to analyze the data and determine the relationships among the independent (teacher training: online, blended, and face-to-face) variables and dependent variables (scores on each subset of the TAC/TAT survey instrument). A one-way ANOVA was conducted to test for relationships among groups. A one-way ANOVA determines if there is a significant difference among groups based on their mean scores (J. Zhang & Liang, 2014). For this study, the three groups are those teachers who received their Montessori training online,

through blended learning, or through face-to-face training. The one-way ANOVA rests on three basic assumptions that must be accounted for (Adams & Lawrence, 2018). First, it assumes that the dependent variable is normally distributed in each group. In order to ensure normality, the descriptive statistics were tested using the Shapiro-Wilk test for normality (Laerd Statistics, n.d.). The second assumption of the one-way ANOVA is that there is a homogeneity of variances, or that variance in each group is equal. In order to ensure homogeneity of variance, the Levene Test for Homogeneity of Variance was performed (Laerd Statistics, n.d.). Third, the one-way ANOVA test assumes that observations are independent. In order to account for this assumption, the confidentiality of participants helps to ensure that they have no personal or professional relationship to the researcher.

Ethical Considerations

Participants for this survey were members of Montessori-related Facebook groups. A key ethical consideration is the use of data and privacy for participants recruited from Facebook groups in order to protect their safety and confidentiality. As Solberg (2010) noted, the main ethical consideration for Facebook users is the use of data mining that does not require informed consent. This study does not use any publicly available data on any individual participant.

The survey instrument was hosted and distributed through Qualtrics and is password-protected. All participation is voluntary and confidential and no personal contact information was collected or stored. There was no use of participant names and only general demographic data were collected, including gender, location, and details of teaching experience and background as it relates to the survey topic. Instead, participants had a number generated according to when they took the survey. In addition, as part of the survey, participants provided informed consent according to the requirements of the Institutional Research Board. See

Informed Consent Document in Appendix D. The data will be stored on Qualtrics for up to 1 year after the conclusion of the survey. It will be stored on an external drive after that for an additional year. The external drive is also password protected. At the end of this time, all data will be destroyed.

Summary

Because the COVID-19 global pandemic cuts across all areas of society, collecting reliable and valid data about the experience requires casting a wide net. By utilizing Montessori-specific Facebook groups, this research study has access to a large population from which to recruit a sample that reflects the broad experiences of Montessori educators during these special conditions. This causal comparative study seeks to determine the difference, if any, between a teacher's own training background (blended, online, face-to-face) and their attitudes and beliefs about technology in general as well as its use under current conditions but within the Montessori paradigm. A reliable and validated quantitative survey instrument examines Montessori teacher attitudes and beliefs toward the integration of technology in their classrooms. All participant data will remain confidential.

Chapter 4

Results

Overview

The research study was conducted in autumn of 2021, eventually recruiting a total of 214 participants. These participants represented a wide range of geographical locations and applicable teaching experience. Descriptive statistics were collected for each participant as well as their answers to each of the nine subscales on the TAC/TAT survey instrument. Each of the three teaching backgrounds (face-to-face, blended, and online) reached the necessary threshold of $n = 50$ in order to achieve a balance among the independent variables. The dependent variables, or the scores on each subscale, were then calculated in order to examine their possible causal comparison.

Research Questions

The research question it seeks to clarify is:

RQ: Are there differences in attitudes to the integration of technology as measured on the TAC/TAT among teachers of three training backgrounds: online, blended, and face-to-face?

Null Hypotheses

$H1_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

H1: There is a difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

$H2_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

H2: There is a difference on one or more subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

$H3_0$: There is no difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

H3: There is a difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

Descriptive Statistics

Descriptive statistics were collected on several factors: years of teaching experience, gender, location, and age. The most significant set of descriptive statistics to this research is the teacher training background (see Table 8). According to the requirements of Gpower, the sample needed to reach a minimum of 200 participants, with a minimum of $n = 50$ for each of the three subsets. The research focuses on the teacher training background. For the purpose of exclusion, we have included the category of "self-taught" in order to remove those individuals who did not attend any formal training.

Table 8

Frequencies and Percentages, Teacher Training Background

Background	*F*	%
Self-taught	5	2.40
Face-to-face	76	36.54
Blended	63	30.29
Online	64	30.77
Total	208	100.00

Results

A breakdown of the other descriptive statistics according to the study variables is shown in Table 9.

Table 9

Percentages and Frequencies for Study Variables by Teacher Training Background

Value	Face-to-face		Blended		Online		Total
	%	*f*	%	*f*	%	*f*	
Teaching experience (years)							
0–1	12.50	1	12.50	1	50.00	4	6
2–5	6.25	2	37.50	12	50.00	16	30
6–10	30.00	30	35.00	35	34.00	34	99
11–15	50.00	23	32.61	15	17.39	8	46
15+	90.91	20	0.00	0	9.09	2	22
Gender							
Male	26.83	11	24.39	10	43.90	18	39
Female	38.92	65	31.74	53	27.54	46	164
Nonbinary	0.00	0	0.00	0	0.00	0	0
Prefer not to say	0.00	0	0.00	0	0.00	0	0
Location							

(continued)

Value	Face-to-face		Blended		Online		Total
	%	*f*	%	*f*	%	*f*	
Asia	27.50	11	40.00	16	30.00	12	39
Africa	42.11	8	21.05	4	26.32	5	17
Oceania	33.33	11	30.30	10	33.33	11	32
Europe	41.03	16	30.77	12	25.64	10	38
North America	36.67	22	28.33	17	35.00	21	60
South America	43.75	7	25.00	4	31.25	5	16
Age (years)							
18–25	25.00	1	25.00	1	0.00	0	2
26–30	9.38	3	43.75	14	40.63	13	30
31–40	33.33	26	37.17	29	29.49	23	78
41–50	27.12	16	30.51	18	40.68	24	58
51–60	82.14	23	3.57	1	14.29	4	28
61–70	100.00	7	0.00	0	0.00	0	0
70+	0.00	0	0.00	0	0.00	0	0

The purpose of this research study is to determine what relationship, if any, there is between the type of teacher training background (face-to-face, blended, and online) to the 10 subscales on the TAC/TAT. Tables 10 and 11 provide descriptive statistics for the survey results.

Table 10

Means and Standard Deviations for Subscales 1–8

Subscale	Face-to-face		Blended		Online	
	M	*SD*	*M*	*SD*	*M*	*SD*
1. Interest	36.67	0.76	44.01	0.52	45.99	0.50
2. Comfort	28.45	0.85	24.11	0.66	23.24	0.65
3. Accommodation	29.03	0.75	24.38	0.64	23.81	0.62
4. Interaction	27.66	0.74	32.78	0.60	35.74	0.62
5. Concern	37.48	0.68	32.72	0.72	30.73	0.70
6. Utility	31.61	0.63	40.38	0.52	42.58	0.57
7. Absorption	28.01	0.77	32.91	0.70	35.24	0.66
8. Significance	46.83	0.56	60.48	0.63	63.92	0.57

Table 11

Percentages and Frequencies for Subscale 9

Stage	Face-to-face		Blended		Online		Total
	%	*f*	%	*f*	%	*f*	
1. Awareness	0.00	0	0.00	0	0.00	0	0
2. Learning the process	94.12	16	0.00	0	0.00	0	16

(continued)

Stage	Face-to-face		Blended		Online		Total
	%	*f*	%	*f*	%	*f*	
3. Understanding and application of the process	92.59	25	3.70	1	0.00	0	26
4. Familiarity and confidence	45.83	11	29.17	7	20.83	5	23
5. Adaptation to other contexts	21.88	14	37.50	24	37.50	24	62
6. Creative application to new contexts	1.64	1	42.62	26	55.74	34	61

Hypotheses

In order to reject the null hypotheses, the research needs to determine if there is a significant difference between each group on each of the nine subscales of the TAT/TAC. In order to determine this, the first step was to conduct a one-way ANOVA on the scores of each group for each subscale. Following from there, a *t*-test can determine which groups demonstrate a significant difference in their subscale scores relative to each other.

In a one-way ANOVA, the research must determine if the value for $F > F_{crit}$ If so, then the null hypothesis can be rejected for that subscale. For the *t*-test, the research must determine if $t_{Stat} < -t_{Critical}$ two-tail or $t_{Stat} > t_{Critical}$ two-tail. If either of these conditions is true, then the null hypothesis can be rejected for that pair of samples. Table 12 summarizes the ANOVA and *t*-test results, and Tables 13–15 provide detailed results of these tests.

Table 12

Summary, One-Way Analyses of Variance and t*-Tests by Subscale*

Subscale and condition	Analysis of variance			Two-tailed *t*-test		
	F	F_{crit}	Reject	*t*	t_{crit}	Reject
1. Interest	10.60	3.28	Yes			
FB				−4.24	2.07	Yes
FO				−4.46	2.07	Yes
OB				−0.79	2.07	No
2. Comfort	1.00	3.35	No			
FB				1.34	2.10	No
FO				1.44	2.10	No
OB				0.18	2.10	No
3. Accommodation	0.79	3.32	No			
FB				1.16	2.09	No
FO				1.21	2.09	No
OB				0.11	2.09	No
4. Interaction	64.64	3.35	Yes			
FB				−6.47	2.10	Yes
FO				−11.46	2.10	Yes
OB				−4.53	2.10	Yes
5. Concern	7.27	3.32	Yes			

(continued)

Subscale and condition	Analysis of variance			Two-tailed *t*-test		
	F	F_{crit}	Reject	*t*	t_{crit}	Reject
FB				3.92	2.09	Yes
FO				3.52	2.09	Yes
OB				0.91	2.09	No
6. Utility	441.45	3.35	Yes			
FB				−18.72	2.10	Yes
FO				−23.54	2.10	Yes
OB				−15.09	2.10	Yes
7. Absorption	4.43	3.35	Yes			
FB				1.85	2.10	No
FO				2.73	2.10	Yes
OB				1.11	2.10	No
8. Significance	72.91	3.28	Yes			
FB				−9.10	2.06	Yes
FO				−11.45	2.06	Yes
OB				−5.25	2.06	Yes
9. Stage of Technology Adoption	113.97	3.04	Yes			
FB				−11.04	1.98	Yes
FO				−12.88	1.98	Yes
OB				−1.32	1.98	No

Note. FB = face to face & blended; FO = face to face & online; OB = online & blended.

Table 13

One-Way Analysis of Variance

Subscale and source of variation	*SS*	*Df*	*MS*	*F*	*p*	F_{crit}
1. Interest						
Between groups	4.02	2	2.01	10.60	<.001	3.28
Within groups	6.25	33	0.19			
Total	10.27	35				
2. Comfort						
Between groups	1.56	2	0.78	1.00	.380	3.35
Within groups	20.99	27	0.78			
Total	22.55	29				
3. Accommodation						
Between groups	1.49	2	0.75	0.79	.462	3.32
Within groups	28.26	30	0.94			
Total	29.75	32				
4. Interaction						
Between groups	3.34	2	1.67	64.64	<.001	3.35
Within groups	0.70	27	0.03			
Total	4.04	29				
5. Concern						
Between groups	2.19	2	1.09	7.27	.003	3.32
Within groups	4.52	30	0.15			

(continued)

Subscale and source of variation	*SS*	*Df*	*MS*	*F*	*p*	F_{crit}
Total	6.70	32				
6. Utility						
Between groups	6.74	2	3.37	441.45	<.001	3.35
Within groups	0.21	27	0.01			
Total	6.94	29				
7. Absorption						
Between groups	2.72	2	1.36	4.43	.022	3.35
Within groups	8.30	27	0.31			
Total	11.02	29				
8: Significance						
Between groups	9.98	2	4.99	72.91	<.001	3.28
Within groups	2.26	33	0.07			
Total	12.23	35				
9. Stage of Technology Adoption						
Between groups	171.97	2	85.99	113.97	<.001	3.04
Within groups	139.58	185	0.75			
Total	311.55	187				

Table 14

Results of t-*Tests*

Subscale and variable	F	B	O	FB	FO	OB
1. Interest (n = 12)						
M	3.06	3.67	3.83			
s^2	0.04	0.20	0.32			
Pooled s^2				0.12	0.18	0.26
$t(22)$				−4.24	−4.46	−0.79
$p(T \leq t)$ one-tailed				<.001	<.001	.222
t_{crit} one-tailed				1.72	1.72	1.72
t_{crit} two-tailed				2.07	2.07	2.07
2. Comfort (n =10)						
M	2.85	2.41	2.32			
s^2	0.02	1.02	1.29			
Pooled s^2				0.52	0.66	1.15
$t(18)$				1.34	1.44	0.18
$p(T \leq t)$ one-tailed				.098	.084	.429
t_{crit} one-tailed				1.73	1.73	1.73
t_{crit} two-tailed				2.10	2.10	2.10
3. Accommodation (n = 11)						
M	2.64	2.22	2.16			
s^2	0.33	1.14	1.35			

(continued)

Subscale and variable	F	B	O	FB	FO	OB
Pooled s^2				0.74	0.84	1.25
$t(20)$				1.16	1.21	0.11
$p(T \leq t)$ one-tailed				.131	.200	.457
t_{crit} one-tailed				1.72	1.72	1.72
t_{crit} two-tailed				2.09	2.09	2.09
4. Interaction (n = 10)						
M	2.77	3.28	3.57			
s^2	0.03	0.03	0.01			
Pooled s^2				0.03	0.02	0.02
$t(18)$				−6.47	−11.46	−4.53
$p(T \leq t)$ one-tailed				<.001	<.001	<.001
t_{crit} one-tailed				1.73	1.73	1.73
t_{crit} two-tailed				2.10	2.10	2.10
5. Concern (n = 11)						
M	3.41	2.97	2.79			
s^2	0.02	0.12	0.32			
Pooled s^2				0.07	0.17	0.22
$t(20)$				3.92	3.52	0.91
$p(T \leq t)$ one-tailed				<.001	.001	.187
t_{crit} one-tailed				1.72	1.72	1.72

(continued)

Subscale and variable	F	B	O	FB	FO	OB
t_{crit} two-tailed				2.09	2.09	2.09
6. Utility (n = 10)						
M	3.16	4.04	4.26			
s^2	0.02	0.00	0.00			
Pooled s^2				0.01	0.01	0.00
t(18)				−18.72	−23.54	−15.09
$p(T \leq t)$ one-tailed				<.001	<.001	<.001
t_{crit} one-tailed				1.73	1.73	1.73
t_{crit} two-tailed				2.10	2.10	2.10
7. Absorption (n = 10)						
M	2.80	3.29	3.52			
s^2	0.48	0.22	0.22			
Pooled s^2				0.35	0.35	0.22
t(18)				1.85	2.73	1.11
$p(T \leq t)$ one-tailed				.040	.007	.141
t_{crit} one-tailed				1.73	1.73	1.73
t_{crit} two-tailed				2.10	2.10	2.10
8. Significance (n = 14)						
M	3.35	4.32	4.57			
s^2	0.14	0.02	0.01			

(continued)

Subscale and variable	F	B	O	FB	FO	OB
Pooled s^2				0.08	0.08	0.02
$t(26)$				−9.10	−11.45	−5.25
$p(T \leq t)$ one-tailed				<.001	<.001	<.001
t_{crit} one-tailed				1.71	1.71	1.71
t_{crit} two-tailed				2.06	2.06	2.06
9. Stage of Technology Adoption						
M	3.39	5.29	5.46			
s^2	1.24	0.56	0.41			
n	67	58	63			
Pooled s^2				0.93	0.84	0.48
df				123	128	119
t				−11.04	−12.88	−1.32
$p(T \leq t)$ one-tailed				<.001	<.001	.095
t_{crit} one-tailed				1.66	1.66	1.66
t_{crit} two-tailed				1.98	1.98	1.98

Note. The hypothesized mean difference was zero for every test. The two-tailed value of $p(T \leq t)$ is twice the one-tailed value of $p(T \leq t)$. F = face-to-face; B = blended; O = online; FB = F & B; FO = F & O; OB = O & B.

Table 15

Tests of Normality and Homogeneity

	Shapiro-Wilk			Levene		
Subscale and condition	*W*	*p*	Normal	*F*	*P*	Homogeneous
1. Interest	0.850	.011	No			
FB				0.72	.404	Yes
FO				1.24	.278	Yes
OB				0.11	.738	Yes
2. Comfort	0.873	.002	No			
FB				31.49	<.001	No
FO				32.64	<.001	No
OB				0.29	.600	Yes
3. Accommodation	0.886	.002	No			
FB				3.41	.080	Yes
FO				4.40	.049	No
OB				0.09	.773	Yes
4. Interaction	0.921	.028	No			
FB				0.35	.600	Yes
FO				2.12	.163	Yes
OB				0.53	.475	Yes
5. Concern	0.953	.162	Yes			
FB				5.73	.027	No

(continued)

Subscale and condition	Shapiro-Wilk			Levene		
	W	*p*	Normal	*F*	*P*	Homogeneous
FO				6.73	.017	No
OB				1.19	.288	Yes
6. Utility	0.799	.093	No			
FB				21.14	<.001	No
FO				22.26	<.001	No
OB				0.00	1.000	Yes
7. Absorption	0.919	.025	No			
FB				2.81	.111	Yes
FO				2.82	.111	Yes
OB				0.00	.996	Yes
8. Significance	0.852	.011	No			
FB				18.28	<.001	No
FO				20.78	<.001	No
OB				0.51	.481	Yes
9. Stage of Technology Adoption	0.844	.012	No			
FB				12.98	<.001	No
FO				22.41	<.001	No
OB				0.73	.396	Yes

Note. FB = face-to-face & blended; FO = face-to-face & online; OB = online & blended.

Based on this analysis of the data, some of the null hypotheses can be rejected for one or more subscale between one of more of the three teacher training backgrounds. H1 refers to the

differences among online training and face-to-face training. H2 refers to the differences among blended training and face-to-face training. H3 refers to the differences in online training compared to blended training.

For H1 (online and face-to-face), the null hypothesis can be rejected for subscales 1(Interest), 4(Interaction), 5(Concern), 6(Utility), 7(Absorption), 8(Significance), and 9(Stage of Technology Adoption). Thus, the null hypothesis can be rejected for seven of the nine subscales. However, as the one-way ANOVA rests on assumptions of normality and homogeneity, the Shapiro-Wilk and Levene tests were performed. For this study, the three groups are those teachers who received their Montessori training online, through blended learning, or through face-to-face training. First, it assumes that the dependent variable is normally distributed in each group. In order to ensure normality, the descriptive statistics were tested using the Shapiro-Wilk test for normality (Laerd Statistics, n.d.). In terms of the Shapiro-Wilk test, only the scores on subscale 5(Concern) are considered normal. However, according to Laerd Statistics (n.d.), the one-way ANOVA is considered robust enough to accommodate a lack in normality as long as the sample sizes of the two groups are fairly even, which, in this case, they are.

The second assumption of the one-way ANOVA is that there is a homogeneity of variances, or that variance in each group is equal. In order to ensure homogeneity of variance, the Levene Test for Homogeneity of Variance was performed (Laerd Statistics, n.d.). In terms of the Levene test, homogeneity between online and face-to-face training data was found on subscales 1(Interest), 4(Interaction), and 7(Absorption). Based on these findings, the null hypothesis can still be rejected because differences on one or more subscales is found to be homogenous and normal.

For H2 (blended and face-to-face), the null hypothesis can be rejected for subscales 1(Interest), 4(Interaction), 5(Concern), 6(Utility), 8(Significance), and 9(Stage of Technology Adoption). Thus, the null hypothesis can be rejected for six of the nine subscales. However, as the one-way ANOVA rests on assumptions of normality and homogeneity, the Shapiro-Wilk and Levene tests were performed. For this study, the three groups are those teachers who received their Montessori training online, through blended learning, or through face-to-face training. First, it assumes that the dependent variable is normally distributed in each group. In order to ensure normality, the descriptive statistics were tested using the Shapiro-Wilk test for normality (Laerd Statistics, n.d.). In terms of the Shapiro-Wilk test, only the scores on subscale 5(Concern) are considered normal. However, according to Laerd Statistics (n.d.), the one-way ANOVA is considered robust enough to accommodate a lack in normality as long as the sample sizes of the two groups are fairly even, which, in this case, they are.

The second assumption of the one-way ANOVA is that there is a homogeneity of variances, or that variance in each group is equal. In order to ensure homogeneity of variance, the Levene Test for Homogeneity of Variance was performed (Laerd Statistics, n.d.). In terms of the Levene test, homogeneity between face-to-face and blended training data was found on subscales 1(Interest), 3(Accommodation), 4(Interaction), and 7(Absorption). Based on these findings, the null hypothesis can still be rejected because differences on one or more subscales is found to be homogenous and normal.

For H3 (online and blended), the null hypothesis can be rejected for subscales 4(Interaction), 6(Utility), and 8(Significance). Thus, the null hypothesis can be rejected for three of the nine subscales. However, as the one-way ANOVA rests on assumptions of normality and homogeneity, the Shapiro-Wilk and Levene tests were performed. For this study, the three

groups are those teachers who received their Montessori training online, through blended learning, or through face-to-face training. First, it assumes that the dependent variable is normally distributed in each group. In order to ensure normality, the descriptive statistics were tested using the Shapiro-Wilk test for normality (Laerd Statistics, n.d.). In terms of the Shapiro-Wilk test, only the scores on subscale 5(Concern) are considered normal. However, according to Laerd Statistics (n.d.), the one-way ANOVA is considered robust enough to accommodate a lack in normality as long as the sample sizes of the two groups are fairly even, which, in this case, they are.

The second assumption of the one-way ANOVA is that there is a homogeneity of variances, or that variance in each group is equal. In order to ensure homogeneity of variance, the Levene Test for Homogeneity of Variance was performed (Laerd Statistics, n.d.). In terms of the Levene test, homogeneity between online and blended training data was found on subscales 1(Interest), 2(Comfort), 3 (Accommodation), 4 (Interaction), 5 (Concern), 6 (Utility), 7 (Absorption), 8 (Significance), and 9 (Stages of Technology Adoption). Based on these findings, the null hypothesis can still be rejected because differences on one or more subscales is found to be homogenous and normal.

Summary

In summary, this quantitative causal-comparative research study sought to clarify the research question of what differences might exist regarding the attitudes toward technology of early childhood Montessori teachers based on their teacher training background, namely online, blended, or face-to-face. In regard to H1 (online and face-to-face), the null hypothesis can be rejected because differences on one or more subscales were found. In regard to H2 (face-to-face and blended), the null hypothesis can be rejected because differences on one or more subscales

were found. In regard to H3 (blended and online), the null hypothesis can be rejected because differences on one or more subscales were found.

Chapter 5

Conclusions and Recommendations

The problem investigated in this research study relates to the attitudes toward technology of early childhood educators, particularly those following the Montessori pedagogical framework. Montessori educators have long enjoyed a reputation as hands-on educators, making a transition to distance learning during the conditions of the COVID-19 pandemic a particularly difficult one. The purpose of this quantitative causal comparative study is to compare a teacher's own training background and their attitude toward adapting their classroom using technology during the global pandemic. This quantitative causal-comparative research study sought to clarify the question of whether there were differences in teacher attitudes to technology related to the type of teacher training background (online, face-to-face, and blended).

The research question is:

RQ: Are there differences in attitudes to the integration of technology as measured on the TAC/TAT among teachers of three training backgrounds: online, blended, and face-to-face?

$H1_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

H1: There is a difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to face-to-face training.

$H2_0$: There is not a difference on one or more of the subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

H2: There is a difference on one or more subscales of the TAC/TAT between teachers who have received blended training compared to face-to-face training.

$H3_0$: There is no difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

H3: There is a difference on one or more subscales of the TAC/TAT between teachers who have received online training compared to blended training.

These differences were measured for each of the nine subscales of the TAC/TAT survey instrument. There followed three causal-comparative hypotheses. H1 referred to the differences among scores for teachers from online and face-to-face training backgrounds. H2 referred to the differences among scores for teachers from face-to-face and blended training backgrounds. H3 referred to the differences among scores for teachers from blended and online training backgrounds.

In choosing a methodology for this research study, there were various pathways to investigation. While qualitative research provides a much more detailed understanding of the experiences of participants, quantitative research allows us to provide a snapshot in time. As this research is particularly interested in how the current conditions of the COVID-19 pandemic might influence teacher attitudes toward technology in ways that might not be relevant to their overall experience, a quantitative research approach appears more relevant. In narrowing down the type of quantitative research, this research study focused on ex post facto researcher, or an analysis of existing conditions rather than experimental ones imposed by the researcher. In a quantitative causal comparative research study, the researcher compares groups based on an independent variable with a dependent variable in order to identify if there are differences between the groups. In this quantitative causal comparative research study, the independent variable is the teacher training background (online, face-to-face, and blended) and the dependent variable is the score on each subscale of the TAC/TAT.

Conclusions

For each of the three hypotheses, the research study examined the scores on each of the nine subscales of the TAC/TAT survey instruments. The study was able to attain 214 responses, meeting its minimum of 200 (Faul et al., 2009) It also was able to attain $n = 50$ for each of the three subgroups. The one-way ANOVA rests on three basic assumptions, which must be accounted for (Adams & Lawrence, 2018). First, it assumes that the dependent variable is normally distributed in each group. In order to ensure normality, the descriptive statistics were tested using the Shapiro-Wilk test for normality (Laerd Statistics, n.d.). The second assumption of the one-way ANOVA is that there is a homogeneity of variances, or that variance in each group is equal. In order to ensure homogeneity of variance, the Levene Test for Homogeneity of Variance was performed (Laerd Statistics, n.d.). Third, the one-way ANOVA test assumes that observations are independent. In order to account for this assumption, the confidentiality of participants helps to ensure that they have no personal or professional relationship to the researcher.

Conclusions for H1

For H1, the differences among scores for the teachers from online and face-to-face training backgrounds were compared. Using the one-way ANOVA, I was able to reject the null hypothesis. Differences were found on seven of the nine subscales. After accounting for the assumptions of normality and homogeneity, I was able to reject the null hypothesis for one (normality) and three (homogeneity) subscales. Thus, I can reject the null hypothesis for H1.

In determining the differences in attitudes among those training online and face-to-face, the seven areas of difference were Interest, Interaction, Concern, Utility, Absorption, Significance, and the Stage of Technology Adoption. There is much corresponding evidence in

the research base as to the difficulties that many teachers have in adjusting to the use of technology in the classroom (Banas, 2010; Derbel, 2017; Kimmons et al., 2015). The differences among those who studied in a face-to-face training environment and those who studied completely online are the most striking among the related hypothesis. The cultivation of the Montessori teacher identity through hands-on, experiential face-to-face training might provide some insight into why Montessori teachers trained in the traditional manner might see themselves and their work differently from other early childhood educators or educators in general (Sibley et al., 2017).

Conclusions for H2

For H2, the differences among scores for the teachers from face-to-face and blended training backgrounds were compared. Using the one-way ANOVA, I was able to reject the null hypothesis. Differences were found on six of the nine subscales. After accounting for the assumptions of normality and homogeneity, I was able to reject the null hypothesis for one (normality) and four (homogeneity) subscales. Thus, I can reject the null hypothesis for H2.

In determining the differences between blended and face-to-face training backgrounds, the key subscales were Interest, Interaction, Concern, Utility, Significance, and Stage of Technology Adoption. While the differences between face-to-face and blended training backgrounds is not as strong as that between face-to-face and online training backgrounds, there remains clear differences between the two on a majority of subscales. As with online training backgrounds, blended training backgrounds demonstrate a difference in the ways that the teachers evaluate their own Stage of Technology Adoption. This reflects the specific understanding of what a learning environment should be based on Montessori training and practice (Bennets & Bone, 2019). The environment as the third teacher, reinforced in face-to-

face and blended training backgrounds, has a strong influence on the cultivation of the Montessori mindset and teacher identity (Branch, 2017; Wafford & Rigaud, 2019). This Montessori identity is often cited as the reason why Montessori teachers and their related educational organizations prefer to work without technology in the classroom (O. Christensen, 2019; Kirkham & Kidd, 2017; Powell, 2016).

Conclusions for H3

For H3, the differences among scores for the teachers from online and blended training backgrounds were compared. Using the one-way ANOVA, I was able to reject the null hypothesis. Differences were found on three of the nine subscales. After accounting for the assumptions of normality and homogeneity, I was able to reject the null hypothesis for one (normality) and all nine (homogeneity) subscales. Thus, I can reject the null hypothesis for H3.

The differences among scores for the teachers from online and blended training backgrounds are not as stark as those of the other related hypotheses. Differences were found on three of the nine subscales: Interaction, Utility, and Significance. What is most telling is that there is no difference in their responses to Subscale 9: Stages of Technology Adoption. This subscale is formulated differently from the other subscales. Instead of a series of questions rated on a Likert Scale, Stages of Technology Adoption is a multiple-choice question in which participants rate their own adoption of technology. While face-to-face training backgrounds had differences with both blended and online training backgrounds in terms of how they saw their own technology adoption, these differences were not found when online and blended training backgrounds were compared. Stages of Technology Adoption relates to the concept of teacher self-efficacy, of the confidence the teacher feels in their own teaching (Joo et al., 2018; Petko, 2012). While a teacher with a face-to-face training background might feel a high level of self-

efficacy in terms of the Montessori pedagogical framework, this same sense of self-efficacy can shift when faced with the need to adapt to technology in the classroom (Blackwell et al., 2014; Dansereau & Wyman, 2020). The connection between teaching beliefs and self-efficacy forms a powerful factor in technology adoption by teachers (Sang et al., 2010).

Other Conclusions

While I was able to reject the null hypothesis for all three hypotheses, there are some significant differences between the three groups. Those from face-to-face training backgrounds were more different from the online and blended groups than those two groups were to each other. This would imply that there might be more distinguishing face-to-face training from the other two possible training backgrounds. At this stage, I cannot make any conclusions on why that would be the case.

Recommendations

Based on the literature review of the topic, much research still needs to be collected in regard to the main themes of this research study. The attitudes toward technology by early childhood educators, particularly those from Montessori or other constructivist pedagogical frameworks, remain a relatively untapped community (Blackwell et al., 2014; Caldwell, 2020). The ongoing effects of the COVID-19 pandemic continue to create conditions where such early childhood educators require more knowledge and familiarity with educational technology tools and how to use them in a developmentally appropriate way with young learners (Atiles et al., 2021; Brown et al., 2020). This quantitative causal-comparative research study provided a meaningful starting point in the ongoing discussion of how teacher attitudes toward technology within this sector might be related to their own training background. By finding that there were differences on various subscales of the TAC/TAT survey instrument between the different

teacher training backgrounds, this research study hopes to provide a foundation of data to support ongoing research in this area. The differences were most stark between face-to-face and online training backgrounds followed by face-to-face and blended backgrounds. This indicates that there is a wider gap between the attitudes of teachers from face-to-face training and those of the other training backgrounds.

Recommendation for H1

In Hypothesis 1, there is a difference between those teachers who received face-to-face training and those who received online training. Further research must be done to determine why this is the case and what relevance it has for the future of Montessori education. As many training institutions continue to consider the benefits and drawbacks of online teacher training, these differences in teacher attitudes toward technology are most stark between these two groups. Traditional and online training need to consider the learning environments that their future graduates will encounter and consider how best to support them in a pedagogically sound manner.

Teacher self-efficacy is one of the key issues in which the contrast between the face-to-face and online training background is most noticed. As training institutions continue to reflect on the importance of the Montessori identity, they must also consider how to support that identity under a variety of real-world contexts. Specifically addressing teacher self-efficacy in terms of personal and professional development can help teachers to navigate these differences in perception as they relate to their own self-worth.

Given the importance of the Montessori identity and its inculcation during Montessori training, there is also the possibility that online teacher training is missing some key element of identity formation that results in the differences between face-to-face and online training

backgrounds. Exclusively online training institutions also need to examine the ways in which they build the foundation of the Montessori mindset in order to highlight the commitment to the Montessori framework and constructivist pedagogical framework.

Recommendation for H2

For Hypothesis 2, there were differences found when comparing face-to-face and blending training backgrounds. Many of the same or similar recommendations apply to those education institutions that rely on a blended learning format. Further research must be done to determine why blended training background teachers, who combine both in-person classroom experience and the use of online learning technology, had comparable differences to face-to-face training backgrounds as their exclusively online counterparts had.

The issues of teacher self-efficacy continue to be relevant in the blended learning environment. Blended learning educational organizations as well as exclusively face-to-face training institutions can reflect on how they develop teacher self-efficacy both in terms of hands-on Montessori classroom experience and adaptability to the use of educational technology in their own learning. The inclusion of educational technology in the learning process could create opportunities for modeling adoption of technology in different aspects of Montessori life.

The inculcation of the Montessori teacher mindset is an important aspect of how the novice and experienced teacher sees their place in the classroom and as an advocate for children. Blended learning institutions, just as their face-to-face counterparts, should consider how the building of this Montessori teacher identity is related to the types of experiences they have in a blended learning environment. Specific attention to these matters is relevant in helping blended learning institutions identify the best ways to support the development of Montessori educators.

Recommendation for H3

The differences between blended and exclusively online training backgrounds were not as found on as many subscales of the TAT/TAC as on the two other related hypotheses. While differences did exist, they were not identified on the unique Subscale 9: Stages of Technology Adoption. Teachers with both blended and online training backgrounds had similar levels of confidence in their ability to adapt and utilize technology in positive ways in their lives and in the classroom. Blended and online educational organizations should consider how they can best support their future graduates in developing relevant skills in educational technology.

Subscale 9 most directly relates to the issue of teacher self-efficacy, a key component of Montessori identity. While most research has been on the ways teacher self-efficacy is developed in the traditional face-to-face format, the role of teacher self-efficacy in adapting to technology requires further study to understand what best practices contribute to this phenomenon.

For those with online and blended training backgrounds, the ability to combine the Montessori teacher identity and the self-efficacy in relation to educational technology demonstrates fewer differences than when compared to those who studied exclusively in a face-to-face training environment. Online and blended training institutions can further explore what aspects of their program directly relate to this phenomenon. Such investigations can also highlight what ways the Montessori teacher identity can be communicated in a broad range of potential contexts, reflecting the uncertain nature of future learning during and after the pandemic.

Implications for Future Research

In order to determine what this gap means, for individuals, for training institutes, and for educational organizations, further research is needed. This quantitative study provided a baseline

of data to begin this research. Qualitative studies in which Montessori educators are able to reflect on their own experiences at length can provide meaningful insights into what these differences in attitudes in technology might mean in both in classroom practice and in the understanding of teacher identity that is so fundamental to the Montessori educator mindset (Ahmad et al., 2019; Bhatia, 2014; O. Christensen, 2019; Doldor et al., 2017).

In order to determine why these differences exist, it is important to conduct further research in terms of how the training background directly influences the attitudes that teachers develop toward technology in the classroom. A qualitative study into the experiences of these different teacher groups could help pinpoint some of the key areas of difference as well as provide context in describing their lived experience in the classroom.

At the same time, more research is needed into how teachers from face-to-face training backgrounds and online training backgrounds experience the process of educational technology training. Many traditional models of educational technology training such as the TPACK are outlined in Joo et al. (2018) and Koh et al. (2017). This would require research into the particular types of educational technology that would be most useful and relevant to a Montessori context during the special restrictions of the COVID-19 pandemic.

Building from that, a third recommendation is that Montessorians examine the types of technologies that could support student learning during normal times, rather than only during periods of distress. This would be relevant to a much larger study into the various specific best practices as they relate to Montessori educators trained in the various training formats of online, blended, and face-to-face.

Summary

This quantitative causal-comparative research study sought to clarify the question of whether differences were measurable in teacher attitudes to technology according to the TAC/TAT based on the training backgrounds of the teachers, namely face-to-face, blended, and online. I was able to reject the null hypothesis for each of these three causal-comparisons, establishing that there were differences on one or more subscales of the survey instrument based on what type of teacher training background the participant experienced. I also noted a wider gap between the scores of face-to-face training backgrounds with those of the other two training backgrounds. This research study provides a foundation for further research on the topic, specifically on a more in-depth qualitative exploration of Montessori teacher attitudes toward educational technology and how they have adapted to the conditions of the COVID-19 pandemic.

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APPENDIX A

Permission for Use of TAC/TAT Survey and Figures and Tables for R. W. Christensen & Knezek (2009)

Dissertation use of TAT and TAC instruments

3 messages

Stacy Andell <[redacted]> 15 June 2021 at 10:12
To: LT-IITTL@unt.edu

Dear colleagues,

I am writing in reference to the TAT and TAC instruments available in the Instruments for AssessingEducator Progress in Technology Integration. I understand that these instruments are free to use for scholarly research purposes. I would like to use them in a dissertation I am writing about the attitudes of Montessori teachers towards technology. My dissertation is for the Doctor of Education program at William Taft University. Do I require formal permission to use these instruments? My research is scholarly and not for profit.

Best,
Stacy Andell

[redacted] 20 July 2021 at 06:28

Dear Stacy,
You have our permission to use the TAC and TAT surveys for your research as described. Please be sure to include the proper citation for the instruments you use to the authors.
Best,
Rhonda Christensen

****
Rhonda W. Christensen, Ph.D.
Research Professor

[redacted]

APPENDIX B

Quantitative Survey Instrument

Quantitative Survey Instrument Based on Teacher Attitudes to Information Technology and Teacher Attitudes Toward Computers.

To the Educator:

This questionnaire is derived from well-validated portions of several attitudinal surveys that have been used with teachers in the past. We will use your responses to help develop a profile of how Montessori teachers view technology. Please complete all items even if you feel that some are redundant. This should require about 30 minutes of your time. Usually, it is best to respond with your first impression, without giving a question much thought. Your answers will remain confidential.

You must be 18 years old or older to complete this survey and be a current Montessori guide/student teacher/intern.

Thank you for your cooperation.

Background Information

1. How long have you been teaching?
0-1 years
2-5 years
6-10 years
11-15 years
15+ years

2. How would you rate your experience with technology in the classroom (check all that apply)
I have never used a computer and I don’t plan to anytime soon.
I have never used a computer, but I would like to learn.

I use applications like word processing, spreadsheets, etc.
I use technology for instruction in the classroom.

3. Currently I use the computer approximately _____ hours per week in the classroom.

4. Ideally, I would use the computer approximately _____ hours per week in the classroom.

5. What type of Montessori teacher training did you experience?
No training (self-taught)
Face-to-face program (all classes taught live and in person)
Blended program (some combination of classes taught online and in person)
Online (all classes taught online with no in-person component)

6. Where did you receive your training?
Self-taught
Montessori specific organization
College or university

7. Are you a current Montessori
a. Guide
b. Student Teacher
c. Intern

8. Number of years since your first Montessori training?

9. Gender
Male
Female
Non-binary

10. Location
Asia
Africa
Oceania
Europe
North America
South America

11. Age
18-25
26-30
31-40
41-50
51-60
61-70
70+

Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree						
1.	I think that working with computers would be enjoyable and stimulating. (186)	SD	D	U	A	SA
2.	I want to learn a lot about computers.(103)	SD	D	U	A	SA
3.	The challenge of learning about computers is exciting.(211)	SD	D	U	A	SA
4.	Learning about computers is boring to me.(180)	SD	D	U	A	SA
5.	I like learning on a computer.(181)	SD	D	U	A	SA
6.	I enjoy lessons on the computer.(10)	SD	D	U	A	SA
7.	I can learn many things when I use a computer.(9)	SD	D	U	A	SA
8.	I believe that it is very important for me to learn how to use a computer.(12)	SD	D	U	A	SA
9.	A job using computers would be very interesting. (101)	SD	D	U	A	SA
10.	The people who give me the best ideas for improving teaching also tend to know a lot about computers.	SD	D	U	A	SA
11.	I concentrate on a computer when I use one.(4)	SD	D	U	A	SA
12.	I believe that I am a better teacher with technology.	SD	D	U	A	SA

Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree						
1.	I get a sinking feeling when I think of trying to use a computer. (263)	SD	D	U	A	SA
2.	Working with a computer makes me feel tense and uncomfortable. (230)	SD	D	U	A	SA
3.	Working with a computer makes me nervous. (17)	SD	D	U	A	SA
4.	Computers intimidate me. (227)	SD	D	U	A	SA
5.	Using a computer is very frustrating. (18)	SD	D	U	A	SA
6.	I feel comfortable working with a computer. (15)	SD	D	U	A	SA
7.	Computers are difficult to use. (20)	SD	D	U	A	SA
8.	I think that computers are very easy to use. (13)	SD	D	U	A	SA
9.	I have a lot of self confidence when in comes to working with computers. (88)	SD	D	U	A	SA
10.	Computers are hard to figure out how to use.	SD	D	U	A	SA

Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree						
1.	If I had a computer at my disposal, I would try to get rid of it. (150)	SD	D	U	A	SA
2.	Studying about computers is a waste of time. (192)	SD	D	U	A	SA
3.	I can't think of any way that I will use computers in my career. (74)	SD	D	U	A	SA
4.	I will probably never learn to use a computer. (154)	SD	D	U	A	SA
5.	I see the computer as something I will rarely use in my daily life. (123)	SD	D	U	A	SA
6.	Knowing how to use a computer is a worthwhile skill. (94)	SD	D	U	A	SA
7.	I look forward to having a computer in my home. (164)	SD	D	U	A	SA
8.	Using a computer prevents me from being creative. (257)	SD	D	U	A	SA
9.	You have to be intelligent to work with comptuers. (261)	SD	D	U	A	SA
10.	Not many people can use computers. (262)	SD	D	U	A	SA
11.	I would never take a job where I had to work with computers. (272)	SD	D	U	A	SA

Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree						
1.	The use of Electronic mail (E-mail) makes the student feel more involved. (282)	SD	D	U	A	SA
2.	The use of E-mail helps provide a better learning experience. (284)	SD	D	U	A	SA
3.	The use of E-mail makes a class more interesting. (281)	SD	D	U	A	SA
4.	The use of E-mail helps the student learn more. (283)	SD	D	U	A	SA
5.	The use of E-mail increases motivation for class. (280)	SD	D	U	A	SA
6.	More courses should use E-mail to disseminate class information and assignments. (276)	SD	D	U	A	SA
7.	The use of E-mail creates more interaction between students enrolled in the course. (278)	SD	D	U	A	SA
8.	The use of E-mail creates more interaction between student and instructor. (279)	SD	D	U	A	SA
9.	E-mail provides better access to the instructor. (277)	SD	D	U	A	SA
10.	E-mail is an effective means of disseminating class information and assignments. (274)	SD	D	U	A	SA

Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree						
1.	Computers are changing the world too rapidly. (142)	SD	D	U	A	SA
2.	I am afraid that if I begin to use computers I will become dependent upon them. (215)	SD	D	U	A	SA
3.	Computers dehumanize society by treating everyone as a number. (138)	SD	D	U	A	SA
4.	Our country relies too much on computers. (135)	SD	D	U	A	SA
5.	Computers isolate people by inhibiting normal social interactions among users. (144)	SD	D	U	A	SA
6.	Computers have the potential to control our lives. (134)	SD	D	U	A	SA
7.	Working with computers makes me feel isolated from other people. (241)	SD	D	U	A	SA
8.	Use of computers in education almost always reduces the personal treatment of students. (176)	SD	D	U	A	SA
9.	Working with computers means working on your own, without contact with others. (251)	SD	D	U	A	SA
10.	The Internet will help narrow the societal gap between the "haves" and "have nots".	SD	D	U	A	SA
11.	Computers will some day be smarter than people. (218)	SD	D	U	A	SA

Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree						
1.	Computers could increase my productivity. (202)	SD	D	U	A	SA
2.	Computers can help me learn. (204)	SD	D	U	A	SA
3.	Computers are necessary tools in both educational and work settings. (226)	SD	D	U	A	SA
4.	Computers can be useful instructional aids in almost all subject areas. (175)	SD	D	U	A	SA
5.	Computers improve the overall quality of life. (207)	SD	D	U	A	SA
6.	If there was a computer in my classroom it would help me to be a better teacher. (163)	SD	D	U	A	SA
7.	Computers could enhance remedial instruction. (168)	SD	D	U	A	SA
8.	Computers will improve education. (162)	SD	D	U	A	SA
9.	Computers can be used successfully with courses which demand creative activities. (170)	SD	D	U	A	SA
10.	Having a computer available to me would improve my general satisfaction. (149)	SD	D	U	A	SA

Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree					
1. I like to talk to others about computers. (98)	SD	D	U	A	SA
2. It is fun to figure out how computers work. (193)	SD	D	U	A	SA
3. If a problem is left unsolved in a computer class, I continue to think about it afterward. (85)	SD	D	U	A	SA
4. I like reading about computers. (100)	SD	D	U	A	SA
5. The challenge of solving problems with computers does not appeal to me. (57)	SD	D	U	A	SA
6. When there is a problem with a computer that I can't immediately solve, I stick with it until I have the answer. (69)	SD	D	U	A	SA
7. Computers can be exciting. (99)	SD	D	U	A	SA
8. I don't think I would do advanced computer work. (60)	SD	D	U	A	SA
9. I will use computers many ways in my life. (54)	SD	D	U	A	SA
10. I like to scan computer journals. (104)	SD	D	U	A	SA

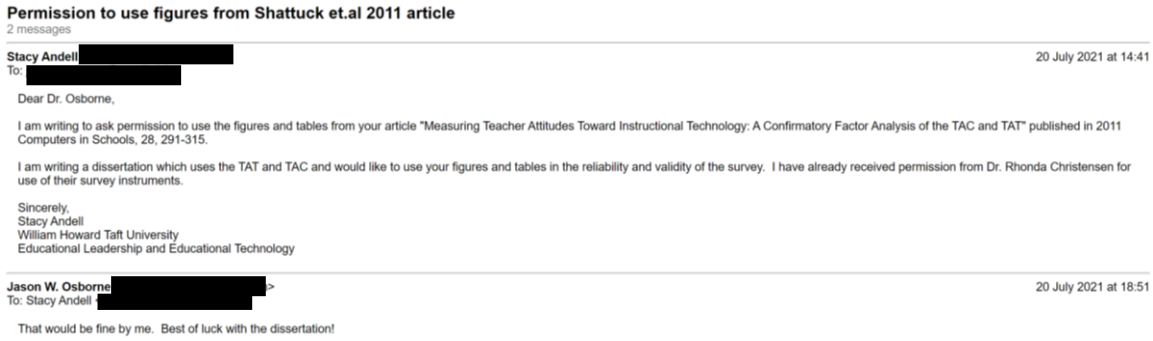
Instructions: Select one level of agreement for each statement to indicate how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree						
1.	It is important for students to learn about computers in order to be informed citizens. (96)	SD	D	U	A	SA
2.	Students should understand the role computers play in society. (172)	SD	D	U	A	SA
3.	All students should have some understanding about computers. (173)	SD	D	U	A	SA
4.	All students should have an opportunity to learn about computers at school. (95)	SD	D	U	A	SA
5.	Computers could stimulate creativity in students. (199)	SD	D	U	A	SA
6.	Computers could help students improve their writing. (198)	SD	D	U	A	SA
7.	Computers can help accommodate different learning styles.	SD	D	U	A	SA
8.	Students work harder at their assignments when they use computers.	SD	D	U	A	SA
9.	Students help one another more while doing computer work.	SD	D	U	A	SA
10.	Student time on the Internet is time well-spent.	SD	D	U	A	SA
11.	Learning about computers is worthwhile. (62)	SD	D	U	A	SA
12.	Having computer skills helps one get better jobs. (97)	SD	D	U	A	SA
13.	I am sure that with time and practice, I can be comfortable working with computers. (216)	SD	D	U	A	SA
14.	Learning to operate a computer is like learning any new skill - the more you practice, the better you become. (214)	SD	D	U	A	SA

Instructions: Please read the descriptions of each of the six stages related to adoption of technology. Choose the stage that best describes where you are in the adoption of technology	
○	**Stage 1: Awareness** I am aware that technology exists but have not used it - perhaps I'm even avoiding it. I am anxious about the prospect of using computers.
○	**Stage 2: Learning the process** I am currently trying to learn the basics. I am sometimes frustrated using computers. I lack confidence when using computers.
○	**Stage 3: Understanding and application of the process** I am beginning to understand the process of using technology and can think of specific tasks in which it might be useful.
○	**Stage 4: Familiarity and confidence** I am gaining a sense of confidence in using the computer for specific tasks. I am starting to feel comfortable using the computer.
○	**Stage 5: Adaptation to other contexts** I think about the computer as a tool to help me and am no longer concerned about it as technology. I can use it in many applications and as an instructional aid.
○	**Stage 6: Creative application to new contexts** I can apply what I know about technology in the classroom. I am able to use it as an instructional tool and integrate it into the curriculum.

APPENDIX C

Permission for Use of Figures and Tables for Shattuck et al. (2011)



Permission to use figures from Shattuck et.al 2011 article

2 messages

Stacy Andell [redacted] 20 July 2021 at 14:41
To: [redacted]

Dear Dr. Osborne,

I am writing to ask permission to use the figures and tables from your article "Measuring Teacher Attitudes Toward Instructional Technology: A Confirmatory Factor Analysis of the TAC and TAT" published in 2011 Computers in Schools, 28, 291-315.

I am writing a dissertation which uses the TAT and TAC and would like to use your figures and tables in the reliability and validity of the survey. I have already received permission from Dr. Rhonda Christensen for use of their survey instruments.

Sincerely,
Stacy Andell
William Howard Taft University
Educational Leadership and Educational Technology

Jason W. Osborne [redacted] 20 July 2021 at 18:51
To: Stacy Andell [redacted]

That would be fine by me. Best of luck with the dissertation!

APPENDIX D

Informed Consent to Participate in Research

Study Title: Montessori Teacher Attitudes to Technology During COVID-19

Researcher: Stacy Andell, William Howard Taft University

We are inviting you to take a survey for research. This survey is completely voluntary. There are no negative consequences if you do not want to participate. If you start the survey, you can always change your mind and stop at any time.

What is the purpose of this study?

This study will explore the attitudes of Montessori educators towards technology with a specific focus on the technological adaptations facing Montessori educators under the conditions of the COVID-19 pandemic.

What will I do?

This survey will ask questions about your background in Montessori, your attitudes and beliefs about technology, and your specific challenges and opportunities as a Montessori educator during the COVID-19 pandemic.

This survey should take about thirty minutes to complete.

Risks

Some questions may be personal. You can skip them or exit the survey at any time.

Breach of confidentiality: There is a chance your data could be seen by someone who shouldn't have access to it. We're minimizing this risk by not collecting personal data.

Possible benefits: This study will gather data about Montessori educators' attitudes and beliefs during the COVID-19 pandemic. We hope to share this information with the Montessori professional community.

Estimated number of participants: 100 current Montessori teachers.

How long will it take: About thirty minutes

Costs: None

Compensation: None

Future research: Your responses may be used or shared for future research studies. However, no personal data will be collected, and all your responses will be confidential.

Where will data be stored? Data will be stored on the researcher's computer and on the Qualtrics website until up to 12 months after the research is complete.

How long will it be kept? Your data will be kept for two years.

Who can see my data?

We (the researchers) will have access to your survey responses. This is so we can analyze the data and conduct the study. None of the survey questions will ask for identifiable information. Agencies that enforce legal and ethical guidelines, such as the Institutional Review Board (IRB) at William Howard Taft University.

We may share our findings in publications and presentations. If we do, the results will be aggregate (grouped) data with no individual results.

Questions about the research, complaints, or problems:

Contact: Stacy Andell

[redacted]

Questions about your rights as a research participant, complaints, or problems:

Contact the William Howard Taft IRB (Institutional Review Board)

Agreement to Participate.

Your participation is completely voluntary, and you can withdraw at any time.

To take this survey, you must be:

At least 18 years old

A current Montessori guide/student teacher/intern

If you meet these criteria and would like to take the survey, choose the “Yes” button below to start. If you do not wish to take the survey, please choose “No” and you will exit out of this survey. You may stop answering questions at any time by closing your web browser.