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Learning in digital environments: a model for cross-cultural alignment

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Abstract

This article presents a conceptual model of cross-cultural alignments in education in the digital era. The intention was to explore and respond to urgent questions regarding learners and the learning environments in today's networked society. The model explores the enabling or constraining influences of educational systems, digital environments, learners, and educators on other learners and is based on the concept of social justice. The skills and competencies required for efficient learner development in a digital environment include digital competence, collaboration skills, intercultural competence, and lifelong learning skills. The interrelationship of these components and their influence on learners' skills and competencies are discussed through the lens of cross-cultural alignment by examining three intercultural projects worldwide. The authors recommend that educational systems provide educational institutions with a high-quality infrastructure as well as to support educators and learners in the development of digital skills. Future research may examine the model's components and their interrelationships so that it may serve researchers and practitioners as a basis for the design of future intercultural projects.

Keywords Learner · Education · Cross-cultural alignment · Digital · Conceptual model

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Introduction

The digital era provides new opportunities for fostering cross-cultural understanding while bridging cross-cultural gaps. These may create challenges for educational systems, such as digital inequalities, ethical issues, and users' well-being. They also offer new opportunities for learning, among them enhanced access to knowledge, learner-centered pedagogy, interaction, and collaboration, all of which are explored here, together with a proposed conceptual model for cross-cultural alignment in educational settings.

Information and communication technologies influence a variety of approaches to teaching and learning. They offer flexible time and space as well as the formation of heterogeneous groups, not possible in the past. Online projects that provide opportunities for collaborative learning in a multicultural environment, even between hostile cultures, have been increasing. In such an environment, learners from different cultures and countries interact, learn together, and form relationships without the stereotypes influenced by external appearances. These online encounters have been found to contribute more successfully to cross-cultural understanding than face-to-face meetings (Hoter et al. 2009). Digital technologies can also help immigrants, minorities, and marginalized groups begin to learn and explore new languages and cultures.

As digital technologies become more prevalent in schools and in our lives, opportunities and new challenges for teaching and learning arise. Developing the skills of lifelong learning, digital competence, intercultural competence, and collaboration are important for both learners and educators. Learners need to develop skills that will enable them to use these digital technologies to create, communicate, and collaborate. Therefore, educators need to design and provide authentic and meaningful digital learning experiences (Finger 2015).

Policymakers, researchers, and practitioners from different countries and cultures that made up the 2019 EDUsummIT group worked online to develop a cross-cultural model, explain the competencies and skills to be developed as well as the components involved: learners, educators, educational systems, and digital environments. The model follows elements of other conceptual models: goal orientation; reduction of complexity; validation; and generalizability/specificity, as proposed by Tondeur et al. (2019).

In this article, we propose digital learning as an educational experience, where in addition to the digital environment serving as a bridge across cultures and connecting all partners, it might create a more efficient environment for cross-cultural alignment. A conceptual model was used to ensure the success and sustainability of such projects. First, we describe the projects implemented in the three of the partners' countries, then we discuss the competencies and skills that are expected to be improved. We then look at the different components involved in these projects and present the model. In the final section, we look at the interactions among the components and bring examples from the cross-cultural projects.

Cross-cultural projects in digital environments

The cross-cultural alignment model is a conceptual model and the various projects underpinned by digital technology closely associated with the authors were an inspiration to building the model. The projects include the TEC (Technology, Education and Cultural Diversity) Project in Israel, NASA's Indigenous Education Institute (IEI)

Program in the US, and The Micool Program in Ireland. Although targeted at different groups in different educational jurisdictions and across different continents, several common elements emerged when the projects were analyzed for comparative purposes. These elements form the core of the model.

The TEC project

The TEC Center develops and implements a collaborative-learning approach based on advanced technologies for lecturers, teachers, pre-service teachers, and for pupils from different ethnic groups and religions, yielding constructive dialogue and cooperation among diversified groups which lead to tolerance and mutual respect. Whereas many projects in other places involve two cultural groups, the TEC Center brings together three (for example, Jews, Muslims, Christians). These groups meet, primarily online, not to talk about conflict or to discuss differences but to advance a joint educational mission. Through these online interactions, they get to know one another as colleagues on an equal basis.

The Center's objectives focus on the development of innovative educational approaches that bridge cultures; using and applying advanced technologies; training teachers from diverse cultural backgrounds to use the internet and other advanced communication technologies as teaching tools while becoming acquainted through small collaborative groups; developing online teaching units that encourage acceptance of those who are "different" and making these units part of the curriculum in schools and teacher-education colleges; creating an intercultural online community comprised of teaching staff; generating ties among teachers, pre-service teachers, and students from different cultures; and stimulating cooperative intercultural ventures among educational institutions and non-profit organizations as well as with the Ministry of Education (Shonfeld et al. 2013).

The indigenous education institute (IEI) project

The Indigenous Education Institute (IEI) creates interest in space sciences among Indigenous and non-Indigenous students in the U.S., while contributing to informal lifelong learning in both communities.

IEI co-develops educational technologies with NASA's STEAM Innovation Lab that are shared with three underrepresented schools in the Southwestern United States. Products have included an Indigenous Eclipse Video, 3D maps for eclipses, geo-mapping projects, and maker kits for maker fairs on the Navajo reservation. Some of the underrepresented schools are not as well funded or equipped. Fortunately, one partner school received a generous startup fund for its makerspace from a NASA spacecraft mission. Teachers of Native American students are eager to learn the kind of STEM materials, activities, and technological opportunities that are available for them (Miller et al. 2018).

IEI is initiating a pilot project with a newly chartered school in the Northwestern United States. It is populated by half Lummi Indian students from the nearby reservation and half non-Indian students, primarily Latino, all at or below poverty level. The school is interested in NASA science as well as Indigenous science and is particularly interested in IEI's activities involving cultural and linguistic development, language retention, cross-cultural exchanges with Navajo and Mongolian students, and developing a makerspace.

The Micool (mobile intercultural collaborative learning) project

Micool was a two-year (2015–2017) Erasmus + project. It aimed to enhance digital integra-
tion in teaching by increasing teachers' digital competence in the innovative use of mobile
devices (i.e. tablets/iPads), promoting cross-cultural learning through the sharing of best
practices across countries, and examining how tablets can be used to support inclusion in
mainstream settings, thus reducing the disparities in learning outcomes affecting disadvan-
taged learners. Uniquely, the project brought together not just distinct cultures from six
countries, but also education systems whose resource capacity varied significantly from
high (Germany and Switzerland) to moderate/average (Ireland and Portugal) to under-
resourced (Poland and Montenegro). At an intercultural level, Micool provided an opportu-
nity for all partners to understand the constraints within which different education systems
operate and to experience how, when educators come together across cultures, the sum
becomes greater than the whole of its parts.

This is evident through partnership-produced resources comprising a bi-lingual web-
site (www.micool.org) which acted as a community of practice while also hosting a range
of teaching and research outputs. The latter are based on cross-cultural collective knowl-
edge and include shared lesson plans when using tablets; a multilingual ebook to promote
the potential of tablets to support intercultural learning and inclusive education of students
with special needs; case studies of the project partners' experiences with different tablet
deployment models (Judge 2017); and a needs analysis on the use of tablets in special edu-
cation. The partners also worked cooperatively to develop an online teacher-training course
across Europe on the use of tablets in the classroom. The project's outputs and processes
illustrate how cross-cultural partnerships utilizing and mediated by technology can support
intercultural integration and learning based on teamwork, cooperation, mutual respect, and
knowledge exchange.

The three projects described above were aimed at developing learners' competencies
and skills: digital competence, collaboration skills, intercultural competence, and lifelong
learning skills. Below, after the description of the skills and competencies, the learning
environment in the cross-cultural projects is discussed. After all the different components
are described, the model, culled from all the components, is presented.

Competencies and skills

Intercultural competence

While countless definitions and models of intercultural competence exist, our use of this
concept is aligned with Deardoff's Model of Intercultural Competence, comprised of three
basic elements: (1) attitudes: respect, openness, curiosity, and discovery; (2) knowledge
and comprehension: cultural self-awareness, deep understanding and knowledge of culture,
culture-specific information, sociolinguistic awareness; and (3) skills: to listen, observe,
and interpret as well as to analyze, evaluate, and relate (Deardoff 2006, p. 254).

In developing these competencies, the learner moves from the personal to the interper-
sonal level, which leads to internal and external outcomes, enabling improved interaction
and communication. For learners to be able to develop intercultural competence, educators
must also develop these attitudes, knowledge, and skills.

Digital competence

Digital competence is an evolving and multifaceted concept that has emerged from different fields including computer literacy, and media literacy, among others. It has been interpreted in different ways in policy documents, in the academic literature, and in teaching and learning certification practices. According to Ilomäki et al. (2016), digital competence seems to be a "loose" concept: one that is not well-defined, still emerging, with varying meanings based on users' different approaches. At a policy level, organizations such as the EU (2010) and OECD (2019) have defined digital competence primarily in terms of the skills and understanding necessary for learners and citizens in order to participate in a knowledge society.

The European Commission published its Digital Competence Framework for Citizens (DigComp) that identified the core components of digital competence across five key areas encompassing: Information and data literacy; Communication and collaboration; Digital content creation; Safety including social well-being and physical and mental health; and Problem solving (Vuorikari et al. 2016). Since its inception, the DigComp framework has been applied to different fields; it now underpins a number of other EU policy initiatives, in particular, the more recently published Digital Competence of Educators—DigiCompEdu framework (Redecker 2017) which focuses on how digital technologies can be used to enhance and assist innovation in education and training while also proposing a progression model to assist educators in assessing and developing their own digital competence.

Lifelong learning skills

Lifelong learning (LLL) nowadays is considered "the guiding principle with which to frame the contribution of education to sustainable development" (UNESCO Institute for Lifelong Learning 2018, p. 11). With the resolution adopted by the General Assembly on September 25, 2015 *Transforming our world: the 2030 Agenda for Sustainable Development, Goal 4*, the UN enjoined member states "to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations 2015, p. 14) This implies the recognition of the right of education at all ages and learning in all settings, both formal and informal. Digital and intercultural competence are among the eight key competencies for LLL (European Commission 2017). In the LLL paradigm, technology is seen as having the potential to empower people and enhance their creativity as well as support their active participation in society. But not all learners have equal opportunities to fully use digital technologies due to social and cultural factors in addition to a lack of interest and confidence (Ala-Mutka 2011). It is therefore important to think of lifelong learning through the perspective of social justice to nurture cross-cultural alignments.

Collaborative skills

A collaborative approach to teaching and learning considered 'Best Practice' is the basis for the Online Collaborative Learning (OCL) theory developed to reflect the skills required in the Information Age (Harasim 2012). Belonging to the Information Age does not necessarily equip students with mastery of the required skills: collaboration

and knowledge construction. In education systems in different countries, these skills have been combined in teaching and learning and a strong emphasis is placed on their implementation. Collaborative learning involves interaction among learners combined with social or professional communication, enabled by accessibility and communication of an online network that creates learning communities. In this way, learning communities become part of the school experience, so that every student may be a part of collaborative processes and their outcomes. In addition, multicultural study groups have the opportunity to explore, develop, and discover cultures that they were otherwise not exposed to through traditional study practices. Consequently, it is essential to train teachers in collaborative teamwork as they will serve as role models for students. While there is no single way to teach teachers how to implement collaborative learning, there is a consensus that it must be part of any teacher-education project (Shonfeld and Gibson 2019).

Learning environment components in cross-cultural projects

The goal of cross-cultural projects is to help the learners develop competencies and skills: digital competence, collaborative skills, intercultural competence, and lifelong learning skills through their interactions with various components: educators, educational systems, digital environments, and other learners. If the components exert an enabling influence on the learners, their level of skills and competencies will increase. If, however, one or a number of components constrain the learners, their level of skills and competencies will not change or change very little. Figure 1 presents the four components and their interactions among them.

Fig. 1 Components and interactions affecting the process
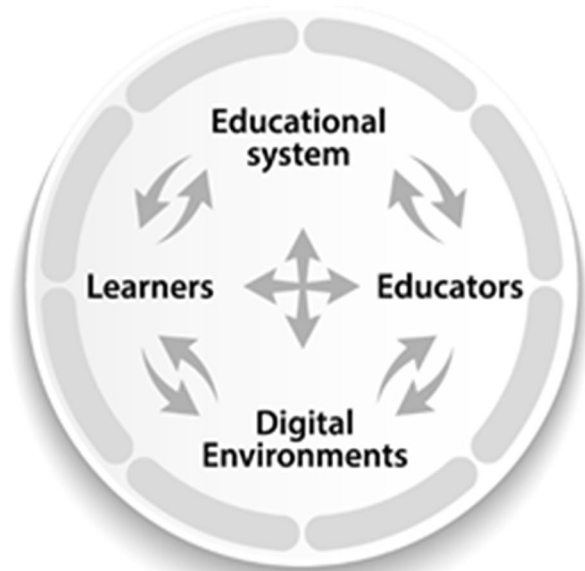
The following section elaborates on each of the components. Each component is described according to the relevant research and theories in the twenty-first century. After a description of the components, the conceptual model will be presented.

Learners

Since the beginning of the twenty-first century, the digital landscape has changed significantly, especially with the arrival of Web 2.0, which allows users to create and share information from different digital platforms, such as social-media networks, blogs, and other data-sharing sites. Consequently, the daily lives of young learners are strongly marked by the use of digital technologies and there is a need to develop learners' digital competence, as one of the key skills of the twenty-first century (Erstad et al. 2018). Clearly a new dimension of digital skills has developed as a result of the massive diffusion of mobile connectivity and the availability of an abundance of information and social relationship options in daily life. Users, in particular, increasingly need to be able to manage digital stimuli so that data can be efficiently channeled towards personal goals and subjective well-being and so that users can avoid excessive multitasking, fragmentation of time during the day, and overconsumption of new media. Thus, digital well-being, a dimension of digital competence, needs to be analyzed from a double perspective, i.e. both individualistically and socially, as it is subjectively rooted in a social context (Gui et al. 2017).

The development of learners' digital competence is far from being homogeneous. There are wide variations among young people both from within the same country and from different countries. The higher the level of socioeconomic development in a country, the higher the level of computer literacy and the feeling of confidence in the use of that technology (Ainley et al. 2018). Therefore, education systems have to deal globally and nationally with digital equity issues among learners.

Several studies have documented the essential and democratizing possibilities of digital composition, remix, and critical digital video production that enable youth to tell their own stories, in their own ways, with their own voices, and in their own languages. However, a broader foundation of research and theory in this field framed by the social, cultural, and linguistic perspectives of youth and their educators, in minority communities where some of these divides are likely to be the most profound, can shed light on the key questions of digital equity (Hadziristic 2017). The model presented here enables researchers, policymakers, and practitioners to consider the urgency of creating digital experiences and products that reflect the cultural and linguistic diversity of learners and provides space for increased representation of minorities.

Deficit theories explain why minority students have poor achievement in educational contexts where their cultural knowledge and prior experiences are viewed as having little or no value and do not lead them to develop their knowledge (Bishop et al. 2014). Educators need to be cognizant that culture, values beliefs, and behaviors play a major role in the learning contexts of learners, helping them to make progress.

Educators

The evolution of digital technologies has provided educators with new ways of accessing and processing knowledge. Technology can potentially transform pedagogy and educators' classroom practices by providing new ways to engage learners (Finger et al. 2015); but it "…requires that educators become lifelong learners who are willing to contend with

ambiguity, frustration and change" (Ertmer 2005, p. 8). Given the added complexity that technology brings to teaching and learning (Koehler and Mishra 2009), the Technological Pedagogical and Content Knowledge (TPACK) framework could help educators integrate technology into their teaching.

For educators to change both their pedagogical practices and thinking to effectively integrate technology, they need to learn more than the technical skills required (Knight 2012). In addition, developing and using culturally responsive pedagogy alongside digital technology could assist educators in catering more effectively for the diverse needs of their learners. Becker (2001) proposes constructivism as a necessary part of progress and change in pedagogy (i.e. basing the construction of understanding and knowledge on one's own experiences, and on the reflection on those experiences). Furthermore, constructivism, together with socio-cultural methods, offer new approaches to support learning and influence pedagogy in ways that contribute to today's understanding of how learners learn (Twining et al. 2013) In constructivist terms, educators change their practices to allow the learner to shape the curriculum and utilize technology to assist in constructing knowledge. However, external factors must also be taken into account, such as the contexts in which educators operate, societal pressures, and government policies and directives (Newhouse 2014).

Professional development for educators may consolidate their knowledge or cause them to question it. Educators develop an awareness of information and skills that are or are not consistent with their current values and beliefs about teaching and learning. This process may create dissonance with their values, beliefs, and philosophy with regard to classroom practices, but it also allows educators to consider the new information, to accept or reject new understanding, and make changes in their current practices or adopt the new practice in its entirety (Prestridge 2010). Educators' personal and professional constructs will also have a bearing on whether and how the technology will be utilized (Newhouse 2014). Constructs, which are shaped by social, cultural and, in the case of educators, educational environments help them to understand past experiences in the context of present and future ones by realizing that change can always take place. Educators bring their existing knowledge and prior experiences to the classroom and, alongside the professional development in which they participate, give shape to their classroom practices. Educators' perceptions and understandings are major influences on how they approach pedagogical practices (Prestridge 2010), including the use of digital technology. Their use of digital technology is vital to their ability to support learners "to become active seekers, users and creators of knowledge who engage with digital technology as a means of discovering and generating knowledge, and increasingly communicate and publish online with an international audience" (Forbes and Rinehart 2019, p. 237).

Cross-cultural alignments support the ability to teach diverse students, serve their families and communities, and provide culturally responsive teaching. The importance of cross-cultural training is emphasized by the National Education Association (NEA 2019) and can be used to provide resources for the development of educators' cultural competence.

Digital environments

A digital environment is created through the use of digital tools and devices to facilitate information gathering, communication, and collaboration (National Academies of Sciences, Engineering and Medicine 2018). While both educators and learners contribute to creating the digital environment in which they work and learn, additional influences that

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shape the digital environment are educators' pedagogical knowledge, technological competency, and attitudes towards the use of technology to support learning.

A plethora of digital tools and software programs/apps are available for educators to create digital environments to support their students' learning and their teaching programs. These include programs that allow students to learn in their own language and at the same time are translated into other languages supporting cross-cultural classes (Shadiev et al. 2018), and others providing access to online dictionaries in a variety of languages, such as Māori in New Zealand (Kupu app), Gaeilge in Ireland (Cúla Caint app) and Cree in Alberta, Canada (Maskwacis Cree app). Barriers to such teaching and learning tools include a lack of access to equipment, insufficient technological knowledge, and negative attitudes of educators towards technology (Williamson-Leadley 2016). To break down barriers in classrooms, educators need to extend their content knowledge, enhance their pedagogical knowledge, and advance their technological knowledge as well as develop culturally responsive practices, using technology that is appropriate for culturally diverse students.

For teachers to support their indigenous and culturally diverse students' learning, not only do they need to surround their TPACK with culturally responsive practices (Gay 2018) but, more importantly, culturally sustaining practices (Alim and Paris 2015). Students' ability to develop effective capability with digital environments depends on the context in which the experience is embedded (Loveless 2000).

In sum, digital technologies may help teachers create or adapt activities that cater to and support their culturally diverse learners. By using technology to personalize learning, teachers are able to focus on their students' individual needs and cultural differences. It is vital for teachers to learn about their students and their cultures, know what digital technology is available, and how it can be utilized to differentiate activities and provide support for their students. Classrooms and online spaces as well as digital resources should be open to students and their communities to better reflect their identities, cultures, experiences, and knowledge (Richards et al. 2007).

Educational systems

Compared to other organizations, schools have been slow to make changes to their traditional practices. Critics argue that despite many pedagogical and technological advances, today's classrooms do not differ significantly from those of the early twentieth century (Robinson 2013). Cuban (1993) argues that dominant school cultures often impede innovation and change. Schein (2004) argues that culture is "a shared system of meaning" based on beliefs, norms, and values that direct how organizations and groups think and act, making change difficult to achieve.

Understanding school culture may help us understand the difficulty of some educators' willingness to adopt technology, and why the computer has failed to transform schooling as hoped. The dominant cultural beliefs about teaching and learning, shared by teachers and society at large, have a strong influence on the change process. These beliefs and norms are reinforced by the organizational structure of schools, meaning that teachers behave in accordance with the norms and expectation of society. Consequently, teachers are more likely to adopt reforms that are consistent with the culture of the school and thus preserve the status quo. This largely explains why technologies, such as the ebook and interactive whiteboard, which extend and enhance traditional classroom practice, have gained acceptance in classrooms. However, more complex technologies which challenge prevailing

practice are either resisted or changed to fit the participating schools (Cuban 1993). In addition, content that deals with intercultural competence including knowledge, attitudes and skills (Deardorff 2006) must be included in the curricula in order to enable teachers to promote cross cultural projects. It would seem, then, that the cultural environment of the school, its dominant organizational structure, and general beliefs in the wider culture about what constitutes "a real school" all coalesce to affect the level of organizational receptiveness to change. However, educational systems differ in their flexibility. The following describes differences between different educational systems in different cultures.

As educational systems are one of the core components of the proposed model of cross-cultural alignment, the authors looked at the educational systems of their countries: Canada, Ireland, Israel, New Zealand, and the USA. While there are similarities in their educational systems, such as compulsory schooling from ages five to 16, there are also differences including types of school attended and authority over schools, curriculum, and composition of the student population.

Types of and authority over schools—In Israel, the school system is divided into Jewish and Arab school systems, with further divisions within each of them. New Zealand has a variety of schooling options with public schools, private schools (co-ed and single-sex), integrated/special character schools, Māori-immersion schools/bi-lingual units, kura (Māori language schools), correspondence schools, and home-schooling. Due to complex historical circumstances, in Ireland, the majority of primary (97%) and post-primary schools (57%) are owned and managed by religious communities, even though the state provides most of the school funding. French and English-language education options are offered in Canada, and some provinces have separate publicly-funded Catholic schools, with private schools also being offered across the country. In the USA, close to 90% of K-12 students attend public schools; others attend state-certified private schools or approved home-school programs.

National curriculum—In Israel, the national curriculum is partially followed by all sectors and subsectors, with the exception of ultra-Orthodox Jewish and independent schools. New Zealand has a national curriculum emphasizing bi-culturalism (Māori, the indigenous people of Aotearoa New Zealand, and NZ Europeans) (Ministry of Education 2007). While there is one national curriculum that schools must adhere to, schools can emphasize the values, needs, and cultural diversity that reflect that particular school community. In Ireland, students at both the primary and post-primary levels follow a state-mandated curriculum where the study of Irish, English, and Mathematics is compulsory. Canadian education is a provincial responsibility under the constitution, meaning that there are systems, rather than a single system, of education, with important differences among them. Curriculum and policies are specific to the visions of provincial and territorial governments. In the USA, state governments set overall educational standards for pre-K-12 schools. In addition, the Bureau of Indian Education (BIE) oversees more than 130 schools across 23 states.

Student Population in schools—In Israel, students attend schools in their neighborhoods where they have little or no interaction with people from other cultures and where unbiased knowledge about them is difficult to obtain. Students are exposed to the stigmas and cultural stereotypes commonly present in the media and the public sphere. In addition, wide gaps exist between the schools serving the different subcultures in budgets, infrastructure, programs, and performance (Hadad Haj-Yahya and Rudnizky 2018). In New Zealand, student cultural diversity has increased, with a growing Asian and refugee population in the country. Ireland's student population has become more culturally diverse over recent years as a result of inward migration during a period of unprecedented economic growth, often referred to as the Celtic Tiger era, spanning the period 1995–2007. Across the US, of the

51 million public school students, 14 million are Hispanic, 8 million Black, and 0.7 million Native American. For 10%, English is a second language (National Center for Education Statistics 2019). Canada, a multicultural country, has a diverse student population with its composition dependent on the province and locale within the province.

These differences in student populations and educational systems increase the value of the model presented here. The influence of the components and the interaction among them is directed to achieving cross-cultural alignment in education.

The cross-cultural alignment model

This model describes the change that the learners undergo when participating in cross-cultural projects that take place in the digital environment. The goal of these projects is to change learners' skills and competencies. This process is influenced—both positively and negatively—by components which include the learners, the educator, the educational system and the digital environments (Fig. 2).

The model is grounded in a social justice framework as digital participation represents a social justice issue in the twenty-first century. As a goal and a process, social justice is based on full and equitable participation of people from all social identity groups in a society that is mutually shaped to meet their needs. The process of attaining the goal of social justice should also be democratic and participatory, respectful of human diversity and group differences, and inclusive and affirming of human agency and capacity for working collaboratively with others to create change (Bell 2016).
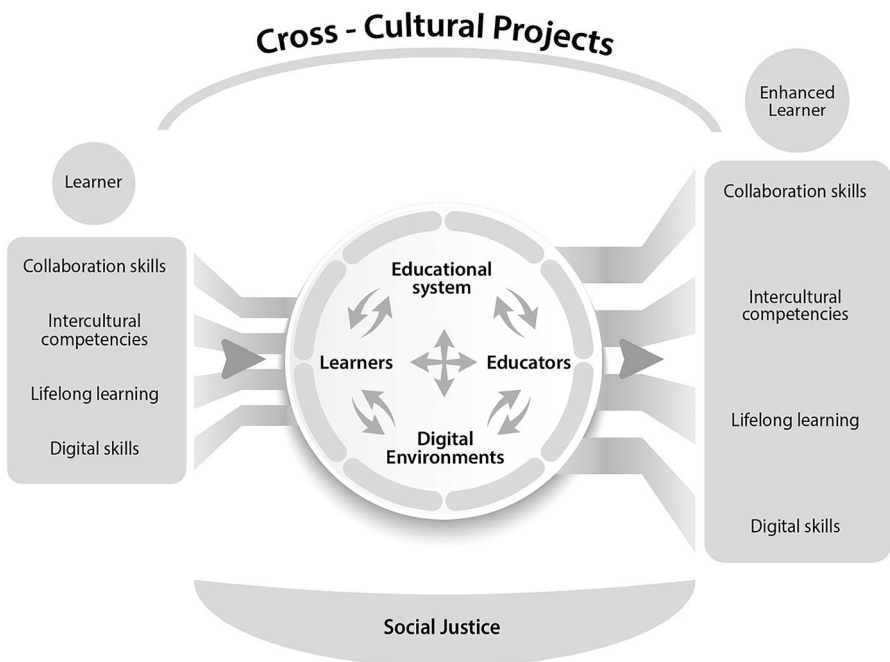

Fig. 2 Cross-cultural alignment model

People cannot fully participate in the digital society if they have to face (1) socioeconomic injustice (when the structures of society generate maldistribution or class inequality for particular social groups), (2) cultural injustice (institutionalized or hierarchical patterns of cultural value generate misrecognition or status inequality for particular social groups), and (3) political injustice. The following conditions are required when seeking social justice online: formal standards of legal equality, an objective condition relating to material resources which guarantees individuals the means and opportunities to interact as peers with others, and an intersubjective condition which supposes that institutionalized models of "interpretation and evaluation" express equal respect for all participants and ensure equal opportunities in the search for social esteem (Fraser 2004). This calls for public policies for digital equity that promote access to educational opportunities which are aimed at extending the capacity of individuals to attain valuable achievements (Verhoeven et al. 2009).

The model identifies key components for cross-cultural learning and alignments to show best practices around the world in bridging theory and practice in digital projects. As all parts of the model are interrelated and interact with each other, interactions need to be in harmony as in an ecosystem, with the components linked through cycles and connections. Examples from the projects explain and discuss these interactions below.

When a learner is in a supportive educational system, has sufficient access to digital technology, is able to interact with other learners and has educators who are skilled and knowledgeable, these enabling influences may enhance the learner's development in intercultural competencies, digital competencies, lifelong learning, and collaboration skills.

Conversely, the limitations or constraining influence of the educational system, lack of access to digital technology, limited interaction with other learners, and/or lack of knowledge/skills of educators may inhibit the development of learners' skills and competencies. The enabling or constraining influence of the components is an aspect that needs to be examined and researched further. A project in a rich digital environment and the same project in a poor digital environment will have different levels of influence on a learner's development of skills and competencies. Research that examines the level of influence of the components and measures the amount of change of the learner's skills and competencies is needed.

The following discussion summarizes the interactions between our model's key elements and elaborates on the skills and competencies that support the flow of the model.

Interactions among the model's components

Learners to learners

Learners are at the center of our model. Indeed, all must adopt the learner role to engage in authentic cross-cultural learning, regardless of age, power, or status within a learning context, as developing intercultural competence requires each person to enter the learning situation with openness and curiosity (Deardoff 2006). Learning takes place not only between teacher and student but also peer to peer (Lai et al. 2018).

Even if young learners are designated as digital natives (Prensky 2001) and grew up in the digital landscape, they generally develop a set of basic procedural skills rather than high-level technological, cognitive, and ethical skills because of the involvement of many factors, such as economic and cultural-capital issues (Brotcorne 2019).

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Therefore, interactions between and within the community of learners are vital to their development of important skills which we believe should include not only digital skills, but skills required for cross-cultural and intercultural connections and learning. For example, the projects in TEC are based on learner–to–learner interactions in a social network where learners build the content through textual and visual interactions (Shonfeld et al. 2013). TEC, IEI, and Micol are examples of the ways that learners can interact and learn from other learners as well as from other cultures.

IEI educators brought their Indigenous and Western science knowledge, including NASA science, to Mongolia for a one-week youth camp. Translations were provided in Russian, English and Mongolian, engaging learners with the Navajo students in the US via Google Hangouts. With a focus on geometry and astronomy in terms of habitations, and clan relationships, they made and shared models of hogan and ger (i.e., traditional dwellings). Hence, the cross-cultural exchange spanned science, language, culture, and modes of living. Faced with similar problems of mining pollution, this cross-indigenous learning reinforced their sense of identity and place.

Learner to educators

In the digital age, the educator is no longer the "sage on the stage," positioned to transfer knowledge (Harasim 2012). Educators now co-create knowledge with their students, learning from, about, and with them, instead of students memorizing information that can be found in a quick internet search. However, it is necessary to train educators to work in this new way and develop their pedagogical and technological knowledge to be able to cater to the diverse needs, interests, and cultural differences of their learners. Barriers to educators' necessary adjustment and changes to this new role could be their attitudes and beliefs about the role of the educator, the role that digital technology can play in supporting their students' learning, and the digital environment they create for their learners. (Romeo 2015). By providing educators with the opportunity to explore new pedagogies with tablets, the Micool Project helped to reduce these barriers. Research conducted with both teachers and students (Judge 2017) reveals a shift away from didactic teaching to student-centered and autonomous learning. As teachers became more proficient with tablets through training and cross-cultural networking, they adapted their teaching style and approach, thus becoming facilitators of learning rather than teachers on the stage. Similarly, TEC is focused on learner-to-learner interactions, based on educational systems (schools and universities), online environments (only after a few months of online learning do the learners meet face-to-face), and educators that are essential for the organization and moderation of learning.

Learner to the educational system

School culture must be taken into account when trying to understand the impact the school has on success or failure of innovative initiatives, including technology. Teachers are more likely to adopt reforms that are consistent with the culture of the school to preserve the status quo (Cuban 1993). Although it is not easy to promote innovations in schools, to change culture and pedagogies, innovation must be part of the educational system's vision and values. Online projects connecting educational systems can help to facilitate the developments of cross-cultural alignments in teaching and learning. For example, the TEC project is funded by the Ministry of Education in Israel, and schools choose it according to their values and beliefs. Similarly, the Micool Project funded by the EU was designed to support

the Council of Europe Education and Training 2020 framework which aimed to improve the quality and efficiency of education and training as well as promoting equity, inclusion, and intercultural dialogue. By aiming to enhance digital integration in teaching and learning through improving European teachers' digital competence with mobile technology, the digital competency of both educators and learners is addressed. This was achieved through online teacher training and a website to support a community of practice based on the sharing of expertise across counties, providing LLL for teacher practitioners as well as intercultural learning and collaboration.

In the Navajo reservation, the school culture is not standardized and there are many different systems and standards. Each school is almost standalone, except for the ones that belong to the public school system or the Bureau of Indian Affairs. This shows the importance of a school's positive interaction with an educational system.

Learner to digital environments

The model offers a way for educators to consider the way in which digital environments shape learners' experiences, highlighting opportunities to develop and apply their digital competence skills (Vuorikari et al. 2016). The selection and use of various digital environments by educators and learners should include opportunities for developing cultural and sociolinguistic self-awareness, discovery of other cultures, and skills to respect and relate to these cultures (Deardoff 2006). For example, the TEC project uses virtual worlds and social networks to support communication in a stigma-free environment, based on avatars and textual communication.

In the Micool Project, learners had the opportunity to enhance their digital competence through classroom use of mobile devices to support learning in all areas, but in particular for STEM and second language learning through using specific apps like Duolingo and the inbuilt recording and audio features on the devices themselves. Students also had the opportunity to interact with and learn from and about students in different jurisdictions through joint projects and intercultural blogging.

Navajo learners who live in homes without electricity have their Chrome Books recharged by a truck that comes around once a week. Since Navajos typically live in multigenerational homes, digital environments have resulted in intergenerational learning. Grandparents are teaching children cultural knowledge, and the children, in turn, teaching them space sciences. Hence, digital environments have made possible a symbiosis of an Indigenous world view and knowledge and Western science knowledge.

Educator to educational systems

While educators have some autonomy within their classrooms regarding the content, pedagogical practices, and resources, they are also bound by the requirements, parameters, and structures of the educational systems in which they work. The influence of educators on the educational system and vice versa can vary depending on the regional, national, or global location of the school. Yet, even when local curricula or policies do not include an explicit focus on intercultural learning, we recommend that educators and learners push boundaries to seek out these important and vital learning opportunities, for example, teachers may request participation in an in-service course funded by the Ministry of Education—even if it's not the school's first priority, such as in the TEC project. In this way, teachers are enabled to explore new pedagogies and learn about other cultures.

The teachers in the Micool Project produced a freely available Open Educational eBook Resource. While creating the ebook, the partners' goal was to create a catalogue of selected good ideas, practices, and tested best examples of using tablets when working with students. The value of the educational projects presented in this ebook is that they support innovation in teaching, help teachers to motivate students, and show how teachers can influence teaching practices in the educational system.

Educators in the Navajo schools emphasize not only STEM, but STREAM (Science, technology, reading, engineering, art, and mathematics) in the Navajo way. Non-native educators are enriched by the cultural experience in the Navajo reservation. When they leave the tribe and go to teach in other school systems, they will bring this enriched experience with them and possibly introduce them into their STREAM curriculum.

Educator to digital environments

Educators choose the digital environments for learning, using technology that fits their pedagogical beliefs (Ertmer et al. 2012). This can create change and innovation, including the adoption of new digital technologies—difficult but not impossible. Projects, such as TEC and Micool, demonstrate that using technology to personalize learning and collaborate across cultures allows teachers to focus on their students' individual needs, support inclusion, and cater to cultural differences. In truly digital environments, classrooms and online spaces as well as digital resources should be open to students (and their communities) to better reflect their identities, cultures, experiences, and knowledge (Richards et al. 2007). While both educators and learners contribute to creating the digital environment in which they work and learn, educators' pedagogical knowledge, technological competency, and attitudes towards the use of technology influence its shape.

As part of the IEI project, a technology specialist who innovated first in the classroom and the community has now brought digital learning to the entire reservation. The maker space with NASA funds has been expanded into a maker place using children's own homes with their own tools (e.g. irrigation, plants) mixing with 3D printers, raspberry pi and zoom meetings.

Digital environments to educational systems

Integrating innovative digital environments in educational systems is difficult. Adopting digital tools' and integrating them in education have consistently fallen short of expectations. This can largely be attributed to deep-rooted attitudes and values opposed to innovation and change (Robinson 2013). However, one of the unanticipated consequences of Covid-19 is the way in which many education systems have had to adapt to new digital environments at lightning speed to ensure continuity in teaching and learning.

Through the TEC project, schools that had not emphasized the integration of digital environments were able to do so in spite of the lack of resources supplied by the educational system. In the Micool project, one of the biggest hurdles faced by the project partners was access to tablets; schools in richer countries had an abundance of devices while those in poorer countries had none. Fortunately, one of the richer partners was upgrading to newer tablets and made its older tablets available to the other partners at significantly reduced prices, meaning that they could purchase 10 s-hand devices. While this helped enormously, it meant that most of the partners were implementing the project on outdated

and inferior equipment and had to use different deployment models based on resource constraints.

Looking at Indigenous cultures, such as Navajo households, internet connectivity is still a challenge for the IEI and the Navajo schools. For digital environments to be sustained in the long run, digital equity needs to be promoted on the level of the educational system and reservation levels.

Taking into account all these varying interactions will help in the success of other cross-cultural projects. The model illustrates the enabling and constraining of all its parts. If we manage to make efficacious use of the interactions of the elements of the model, we will manage to empower the learners and prepare them for the future. The output of the model is the enhanced learner. Learners who have lived the experience of digital cross-cultural projects will see their skills strengthened: collaboration skills, intercultural competencies, lifelong skills and digital competence.

Implications and future research

Policymakers would do well to adopt policies to ensure that education systems, educators, and learners capitalize on the gains that have been made in schools' digital adoption processes. Thus, they would help to reduce the different levels of the digital divide (Resta et al. 2018). High-quality infrastructure; access to meaningful, culturally relevant content in local languages as part of the curricula; opportunity to create, share, and exchange digital content; and access to research dealing with the application of digital technologies need to be provided to educators who assist learners and develop their competencies and skills.

Applying the Cross-Cultural Alignment Model for learning in the digital age has a number of implications for educators. Not only do educators need to provide opportunities for learners to develop lifelong learning skills, digital competence, collaboration skills, and intercultural competence, educators need to develop these skills themselves. By recognizing that learners, their families and the communities the learners are part of, adding to their knowledge and experience, allowing educators to model lifelong learning skills (Rewi 2011). Developing intercultural competencies means that educators need to know about their learners and their culture(s). To bridge this gap, educators should create opportunities to make connections between the classroom curriculum and their learners' diverse knowledge and lived experiences beyond the classroom wall. Culturally sustaining classrooms should support diverse ways for students to develop, express, and share a cumulative understanding of curriculum and knowledge. Teaching learners to develop collaborative skills provides opportunities for them to interact with a variety of other learners and become more globally aware citizens (Gay 2018). Educators need to create digital environments that allow learners to experience a range of digital tools and virtual spaces in order to express themselves and their culture(s) in meaningful and diverse ways. In addition, online spaces should support students' language(s) to better reflect their identities, cultures, experiences, and knowledge (Resta et al. 2018). Thus, the subject of multiculturalism and global citizenship has to be part of the curricula. All the while, educators need to prioritize the needs and interests of their diverse learners through a social justice lens (Bell 2016).

To make these projects applicable for the long-term (10 years or more), it requires multi-institutional collaborations to support coordinated efforts at the necessary levels, within (e.g., TEC) or across countries (e.g. IEI and Mongolia). Coordinated efforts may include but not be limited to: supporting the coordinated efforts in digital environments

and periodic events or campaigns; uniting educators in collaborative networks that cross institutional, geographical, and digital divides; promoting subject areas as well as cross-cultural training of the future workforce; and, fostering partnerships and sponsorships to defray the costs.

This conceptual model offers new ways and avenues of research. Researchers have yet to assess its feasibility. This should be done for example through design-based research, focused on optimizing exemplary projects, such as those described in this paper, could enhance the efficacy and effectiveness of projects. It should include refining the design principles that underpin the design of projects, such as those described in the article. Research should examine the barriers in developing, modifying, and integrating the various components; analyze the impact of different relevant contents and different online environments as well as various cultural environments. It would also be desirable to show the impact of the cross-cultural projects on various groups of learners with treatments as compared to those without. Pre- and post-assessments of cross-cultural learning may demonstrate measurable changes in behavior, attitude, skills, interest or engagement, and knowledge (Friedman 2008). Over time, researchers may identify significant challenges in the model and confirm the levels of technical interchange or negotiation that are required to develop the proposed model. Therefore, researchers could conduct longitudinal studies combining different methods, such as ethnographic approaches, observation, design-based research, etc. Such research would, for example, make it possible to explain the impact of the digital learning environment on the development of learners' skills. Moreover, it directs towards new collaborative research between researchers and practitioners from different socio-cultural contexts.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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