Culture in Computer-Based Learning Systems: Challenges and Opportunities

[a]**Ryan S. Baker,** [µ]**Amy E. Ogan,** [µ]**Michael Madaio,** [c]**Erin Walker**

[a]University of Pennsylvania, [µ]Carnegie Mellon University, [c]University of Pittsburgh

Corresponding author: ryanshaunbaker@gmail.com

Abstract. Computer-based learning technologies are now being used worldwide, but are mostly researched in a small number of countries and contexts. Increasing research suggests that modifications are needed to make computer-based learning responsive for all students worldwide. In this article for the inaugural special issue of Computer-Based Learning in Context, we discuss the virtues and limitations of existing theoretical paradigms of culture and context, relevant to computer-based learning. We note cases where existing approaches are successful, while listing some key phenomena in computer-based learning that fail to be explained by current approaches. We close by unpacking some open questions that limit our ability to make progress on such systems and suggesting some of the attributes of useful next-generation theory on culture and context in computer-based learning. In particular, we discuss possible steps forward that can be used to better operationalize culture and make theory on culture and context more concrete and actionable.

Introduction

Learning systems that provide adaptive or otherwise personalized instruction have had significant success in wealthier countries and populations (Kulik & Fletcher, 2016). The relatively limited research that has been done on specific underserved groups in western wealthy countries, and a few emerging economies, has also shown promise in transforming learning outcomes for students who are outside of the mainstream of research in this field (Huang et al., 2016; Conn, 2017). However, much of this second line of research has also shown that considerable modifications are needed to make these systems responsive for all students worldwide. Mindful that a singular definition of culture is intractable, several studies nonetheless demonstrate that the patterns of how online learning is used differ between cultures and contexts (Kumar et al., 2010; Ogan et al., 2012, 2015), suggesting that there may be significant advantages to representing and adapting to culture and context in educational systems, and potentially large downsides to not doing so. Without considering culture, we risk a narrow view of computer-based learning (CBL) technologies that fails to predict or explain why interventions have the impacts they do in the contexts where they work, and that is unable to identify which interventions or designs are likely to work for new or different populations.

There is increasing evidence that ignoring cultural factors in the design and development of CBL systems can create risk of reduced effectiveness for some groups. For example, Ocumpaugh and her colleagues (2014) found that affect detection models trained on urban and suburban learners functioned much more poorly when applied to rural learners. The risk of lower model quality for some groups is not unique to education. For example, Buolamwini and Gebru (2018) evaluated several commercial facial recognition systems, finding that classification accuracy was significantly worse for people of color and even worse for women of color, which the authors argued was due to a lack of representation of these populations in the training data for the predictive models. The efficacy of an adaptive system's recommendations may be lower for certain populations, particularly those who might have limited representation in the training data (as in Buolamwini and Gebru, 2018). This impact on learning outcomes may also be the result of limited visibility or political power, perhaps indicative of limited access to such computational learning systems, or limited recourse for appealing the performance of the system in the case of an error. This may also be the result of lower accessibility for researchers to work with certain populations of learners (e.g. remote rural communities and learners on Native American reservations). Even steps intended to protect students -- such as legal limitations on access to information on disabilities, or more stringent human subjects protections for historically

underrepresented populations (such as the very restrictive access to student data in some cities) -- may result in lower effectiveness for historically underrepresented populations. Design and development processes must include users of all target cultures and groups, or the CBL that results will likely be more appropriate or effective for members of the dominant culture.

However, developing CBL technologies that are culturally responsive represents a significant challenge. Culturally-adapted learning technologies, and indeed culturally-responsive pedagogy more generally, necessitate careful design, and potentially require significant investment in time and resources to adapt systems to different contexts. There are also disincentives for researchers to research these issues. For those researchers who are already experts in CBL systems in their own context, it is comparatively harder to do work on other populations due to geographic and funding constraints, not to mention the challenges inherent in working in a setting where the expectations and rules are different (Rodrigo et al., 2014). On the other hand, researchers in underrepresented contexts often receive the criticism from reviewers and editors that their work does not "generalize."

What is needed is actionable theory that can guide us in understanding how culture and context can be represented, the roles that they play in the relative success of different pedagogies and instructional systems, as well as the practices, behaviors, and responses that surround these systems in the real world. Such a theory would allow us to predict how specific learning environments are likely to function in particular cultural contexts, enabling the development of well-informed, culturally-responsive pedagogies for CBL.

There remain a number of major obstacles to such actionable theory for CBL systems. The first challenge is selecting an operationalization of culture to be employed. In prior work, two main philosophies have been competing for researchers' attention - one which sees cultures as being represented by a universal set of dimensions (a macro-theoretic approach), and another that looks at each group of individuals as a microcosm (a micro-theoretic approach). In order for CBL systems to function across learners, we need to find a middle ground between an overly essentialist macro-theoretic view, which may obscure factors that do not fit into a small number of dimensions, and a totally situationalist micro-theoretic view, in which every classroom is viewed as completely unique. Second, we must understand the relationship between cultural and contextual factors and the design of learning environments, pedagogies, and pedagogical outcomes, to determine what works and for which contexts. These challenges are interrelated; for adaptive systems to select or produce the most appropriate content or pedagogical methods, these theories must include an operationalization of culture and context that is specific, precise, and actionable.

The goal for this paper is to outline a path forward for the development of culturally-responsive CBL that builds on existing theoretical approaches but overcomes their limitations. In this article, we first review theories of culture that have been used in educational systems, looking at both more micro- and more macro-theories, and identify limitations of these current approaches. We note cases where existing approaches are successful, while listing some key phenomena in computer-based learning that fail to be explained by current approaches. We close by unpacking some open questions that limit our ability to make progress on such systems and suggesting some of the attributes of useful next-generation theory on culture and context in computer-based learning. While we do not expect any single article submitted to this journal to solve the challenges we pose in this paper, we hope that as a collection, this journal's articles can produce the types of data and findings that will lead to significant progress towards the type of theory that this field urgently needs to reach its full potential.

Macro-theories of culture

In this section we lay out some of the prior macro-theories of culture and context that have been guides to work in this area, highlighting successes in making predictions or improving system quality, but also aspects of theories in this category that remain underspecified or inadequate to the task at hand.

Review of Macro-theories. Probably the most prominent category of theory on culture and context is what can be referred to as macro-theories (Fiske, 1992): theories that attempt to categorize all groups in the world according to some number of cultural dimensions. These theories do not attempt to represent all aspects of culture, but some of these theories claim to represent a key set of dimensions that capture the most important variation in culture. Similarly, these theories do not actually attempt to represent all groups, but do attempt to represent a large number of groups, often based on categorizing people in terms of their home countries or national origins. Importantly, these theories broadly attempt to represent the culture of groups of people, typically countries, rather than individuals within those groups, treating members of a group/country as generally sharing the same values for all dimensions of interest.

The most popular and widely used of the macro-theories of culture and context is Hofstede's cultural dimensions theory (Hofstede & Hofstede, 1991; Hofstede, 2011). Hofstede's theory categorizes individuals in a country, as a group, in terms of these six dimensions of culture:

● Power distance	the degree of acceptance of difference in power between different individuals
● Individualism versus collectivism	the degree to which individual people see their identity in terms of membership of groups
● Uncertainty avoidance	the degree to which ambiguity and unexpected behavior or events are tolerated
● Masculinity versus femininity	the degree to which success and assertiveness are preferred by a society versus cooperation and modesty
● Long-term orientation versus short-term orientation	the degree to which tradition is valued versus adaptability
● Indulgence versus restraint	the degree to which society controls and regulates gratification of needs and desires

Hofstede's theory was initially developed based on data from adult workers at a single multi-national corporation, but has since been refined and validated using data from several other cross-national studies. Hofstede has argued for his theory's direct relevance to education (Hofstede, 1986), and has argued that data from other researchers demonstrates the validity of his theory for student populations (Hofstede & Bond, 1984).

Two other large-scale theories compete with Hofstede's model in representing culture, at the national level, in terms of several dimensions. The more widely-cited of these theories is Trompenaars and Hampden-Turner's (2011) Model of National Cultural Differences. This model shares many of the same features as Hofstede's theory, having been developed primarily from data from adult workers, representing individuals in terms of national groupings, and providing scores for a set of dimensions. One dimension of potential particular interest for education researchers in the Trompenaars/Hampden-Turner model, not seen in the Hofstede model, is the neutral versus emotional dimension, thought to represent the degree of emotional expression in a country. The other prominent macro-level theory of culture, used in business contexts, is the GLOBE study (House et al., 2004). The GLOBE study was also developed from data from adult workers, but focused more on managers and higher-level employees. GLOBE also represents individuals in terms of national groupings, using nine dimensions, several of which map directly to dimensions from Hofstede's theory.

A simpler macro-theory is found in the Inglehart-Welzel cultural map (2010), which compares societies based on two dimensions: survival versus self-expression, and traditional values versus secular-rational values. Each of these dimensions captures aspects of multiple dimensions within Hofstede and Trompenaars' models. Although their model is a much less complex representation of culture than the previously discussed models, Inglehart and Welzel argue that these two dimensions capture around 70% of the variance in a very large data set of responses to a broad survey of individual values and preferences. One other major difference between Inglehart-Welzel and the other macro-theories discussed here is that Inglehart-Welzel developed their cultural map based on a stratified national sample rather than workers in a business context. The survey the Inglehart-Welzel model is based on has been administered at scale six times, and as such Inglehart-Welzel's model represents a tradeoff between simplicity (with higher simplicity translating to lower usefulness) and degree of validation (very high).

Ways in which macro-theories have predictive power. With the rise of large-scale internationally available online learning platforms and massive open online courses (MOOCs), researchers have been easily able to analyze learning data from thousands of learners across a large number of countries in a single study to understand how differences in learners' cultures may impact their learning behaviors and outcomes, while controlling for other potentially confounding factors. Macro-theoretical dimensions have been useful in learning sciences research on these systems as independent variables in predictive or quasi-experimental models of educational processes and outcomes across cultures.

A particularly clear example of this is seen in Kizilcec and Cohen (2017), who found that MOOC learners in individualist cultures (according to Hofstede's model) were significantly more likely to complete the course than learners in collectivist cultures, after receiving the same self-regulation intervention. In this intervention, learners were prompted to write out their goals and obstacles before beginning the course, and identify methods for addressing those obstacles. The relationship between course completion and the individualism of learners' culture replicated across two studies, even after evaluating potential confounding factors (Kizilcec and Cohen, 2017). The

authors speculate that the effect that the individualism of learners' culture had in enhancing the effectiveness of the intervention was because the type of if-then planning in the self-regulation intervention was seen as oversimplified and ignoring key external factors and social obligations by members of collectivist cultures.

This effect of power distance on learners' behaviors in online learning settings has been seen in other studies, such as Thayer et al. (2018), who found that learners from higher power-distance cultures placed more trust in the learning environment (as a proxy for the teacher's authority). Specifically, Thayer et al. found that in a popular online learning environment for programming, Python Tutor, learners from cultures with a lower power-distance index were significantly more likely to use non-linear navigation in a visual debugger - i.e. taking more back-steps while programming -- evidence of greater self-direction in their use of Python Tutor. The authors speculate that the power distance index was a proxy for learners' reliance on authority figures like teachers or the Python Tutor's instructions to direct their progression through the interface (Thayer et al., 2018). Collectively, these findings suggest that some of the variables used in macro-theories such as Hofstede's dimensions are relevant to learner behavior.

Empirical Limitations of Macro-Theories. Despite the success stories involving the use of macro-theories to predict learning behaviors, there are a number of larger limitations with the application of existing macro-theories that make them difficult to use as frameworks for the incorporation of culture into educational technologies.

First, there are several phenomena that actively contradict the logical predictions that are made based on macro-theories. For example, it might be reasonable to hypothesize that students from more collectivist countries would be more likely to participate in group collaboration, such as a course forum, than students in more individualistic cultures. Instead, Mittelmeier et al. (2015) found that students from highly individualistic cultures working in an international business school were in fact more likely to post on the course forum, which the authors posit was due to more comfort with free expression in such cultures. Similarly, in their study of preferences and behavior in a computer-supported collaborative learning environment in a large life sciences course, Popov et al. (2014) found that students from individualistic cultures were more likely to prefer to work in groups in the online platform, and were more likely to rate those group experiences positively. Popov et al.also add that the lack of visual cues in the online learning platform was reported by students from collectivist cultures as being an obstacle to effective collaboration. Frambach, Driessen, Beh, and van der Vleuten (2014) also found evidence suggesting that students from collectivist cultures may have more difficulty with group-oriented activities, using comparative case studies of problem-based learning in medical schools in the Netherlands, Hong Kong, and elsewhere. They posit, much like Popov et al., that students in collectivist cultures might be more likely to feel that disagreements were counterproductive to successful group work. At a larger scale, with data from MOOC provider edX, Skrypnyk et al. (2014) found that while learners' stated preferences for working alone or in groups largely aligned with the expectation from Hofstede's cultural model, those preferences did not reflect their actual behavior on the platform. In particular, they found evidence suggesting that learners from individualist cultures posted most often in the courses, despite their stated preference for working alone. This may suggest that our understanding of collaboration -- or students' understanding of collaboration -- may not map to the way collectivism is typically thought to connect to this behavior. Simply posting on a discussion forum may not have the same affordances for collaboration and group work that learners were expecting when describing their preferences. This suggests that the predictive power of macro-theories such as Hofstede's may often be impacted by the affordances of the learning environment that make various aspects of the learning process - here, collaboration norms - more salient for learners.

Second, predictions made by one macro-theory often contradict predictions made by other macro-theories. Though there is broad alignment across theories on many dimensions, some dimensions thought to capture similar constructs across different theories do not agree with each other. For example, despite the high-level similarity between Hofstede's and Trompenaars and Hampden-Turner's models, they differ considerably in terms of the individual dimensions. Beyond having different dimensions -- such as Trompenaars and Hampden-Turner's dimension of Sequential vs Synchronic (relative importance of punctuality) -- they differ in terms of specific countries' places along the scale for common dimensions, in particular individualism versus communitarianism (Trompenaars/Hampden-Turner) or collectivism (Hofstede). Similarly, a comparison between Hofstede's model and GLOBE reveal that despite both involving very large and representative samples of individuals drawn from the same types of occupations, and having dimensions thought to correspond to each other (and even utilizing the same name), the two models disagree considerably. For example, researchers have hypothesized that the dimension of uncertainty avoidance may explain differences in student responses to affective observations, but there is a negative correlation between the GLOBE and Hofstede indices for uncertainty avoidance (Venaik & Brewer, 2008). Which index should be used?

Third, there are many phenomena that cannot be explained at all by dimensions of existing macro-theories, such as off-task behavior, collaborative behavior, and affect detection. Despite the significant differences in culture between nations as distinct as Japan, China, Thailand, and the Philippines, for example, there is much lower incidence of off-task behavior in these nations than in the rest of the world (Chase & Mueller, 1989; Lan et al., 2009; Weisz et al., 1995; Rodrigo et al., 2013). There is no obvious explanation for this pattern in existing cultural macro-theories -- these countries are quite different from each other, and countries that share specific cultural features with these countries, according to dimensional models, do not seem to also have low off-task behavior.

Another regional phenomenon is the collaborative behavior seen in the use of adaptive learning technologies in classrooms in Latin America. In three Latin American countries which are culturally quite distinct from one another -- Mexico, Costa Rica, and Brazil -- students were given an intelligent tutoring system designed for individual use. Unlike students in several other countries, students in these three countries immediately formed collaborative groups and worked together throughout the day, entering answers together and discussing the system's feedback together (Ogan et al., 2012). As with the off-task behavior example, these countries vary on a range of cultural features and are similar in terms of seemingly relevant cultural dimensions (i.e. collectivism in Hofstede's model) to other countries where this behavior was not observed, e.g. the Philippines. Finally, another example of a phenomenon that is not easily explained with existing models is the difficulty of field observers identifying student affect in Mexico (Baker et al., in press). The field observation protocol BROMP has been successfully adapted for use in the USA, Philippines, India, UK, UAE, and China. However, attempts to adapt BROMP for use in Mexico were unsuccessful -- field coders (who themselves were Mexican) were unable to recognize student affect sufficiently well in a public middle school to achieve acceptable inter-rater reliability, and noted that affect was difficult to recognize facially in the population studied.

Phenomenological Limitations of Macro-Theories. Even if these limitations did not exist (i.e., even if the field arrived at a perfect macro-theoretic taxonomy of culture), there are serious epistemological concerns about the "essentialist" nature of designing learning technologies based on cultural models that treat all learners from a single culture as having the same essential nature -- or at least key common attributes which can be seen as essentially omnipresent, within-culture. Epistemologically, a given learner may have multiple cultural identities, and any one (or more) of those identities may be more or less salient for the learner based on the context. For instance, many critics of macro-theoretic models argue that nation-states may contain multiple cultural subgroups (e.g. Basque communities in Spain, Kurds in Iraq, and many more examples), or even multiple nations within the official state (e.g. Scotland, Wales, Northern Ireland, and England within the United Kingdom), and state borders may change or even split into multiple states (as with Yugoslavia, or more recently, Sudan). More broadly, an intersectional view of culture (Crenshaw, 1991) argues that identities are comprised of multiple overlapping components (e.g. race/ethnicity, gender, sexuality, class, dis/ability, religion, language, geography, etc) that are constantly in a state of flux and are always socially constructed and embedded in complex socio-political contexts, a distinct contrast with Hofstede's fixed categories for identities that hew closely to national borders. Approaches such as Hofstede's model provide no clear guidance for how to deal with these issues (McSweeney, 2002; McSweeney, 2013; Baskerville, 2003; Baskerville-Morley, 2005).

These issues have direct implications for the use of educational technologies, as current macro-theoretical approaches are unable to make predictions about sub-groups within a culture. For example, another phenomenon that is not easily explained by current theories is the high levels of engagement seen among rural learners using adaptive learning technologies in the United States. Despite serious social problems that impact education in the rural United States (Edmondson & Butler, 2010), and generally lower educational attainment than in suburban areas (Byun, Meece, & Irvin, 2012), one study has suggested that rural students' engagement is much higher when using educational technologies than suburban students (Baker & Gowda, 2010). Relatedly, there is some evidence that indicators predictive of student engagement differ between rural settings and other regions (Ocumpaugh et al., 2014), but it is not fully understood how or why these differences emerge.

Lastly, from a statistical perspective, there are serious concerns with using aggregate data of group-level populations (here, national) to make inferences about individual members of that population (McSweeney, 2013;Van de Vijver and Poortinga, 2002; Knorr-Cetina, 1988). When this practice is followed, it risks producing Simpson's paradox, where trends discovered in the aggregate may be different (or have the opposite sign) for subgroups (Blyth, 1972). Fisher et al. (2018) found further evidence, across six repeated-measures human subjects studies, that findings from groups should be generalized to individuals only after conducting a diagnostic to ensure homogeneity across individuals within the group, an assumption that is often unwarranted. In fact, Gerhart and Fang (2005) have reanalyzed Hofstede's data to show that only a small fraction (~2-4%) of differences in individual values can be explained by national differences -- a non-zero proportion of variance, but of questionable

applicability for real-time decision-making for individuals. Hofstede himself has acknowledged that national-level models may have limited predictive power for individuals' behaviors (Hofstede, 1980). This has not, however, stopped later researchers from using Hofstede's models to do just that, as discussed elsewhere in this article.

Thus, we have a need to find approaches that take national-level culture into account, but also accounts appropriately for subgroup differences, for the intersectionality found in individuals, and ultimately for the attributes of individuals who differ from the majority of individuals in their cultures in key ways. Micro-theoretical approaches, described in the next section, represent a mechanism for accomplishing this goal, but come with their own drawbacks.

Review of Micro-theories

The Explanatory Power of Micro-theoretical Approaches. Another relevant school of thought in cultural studies that has received less uptake amongst researchers in computer-based learning environments is micro-theoretical approaches. These micro-theories treat culture as the process of "signification," that is, the development and display of shared meaning in one's daily life. In this view, culture is embedded in particular actors' specific practices and activities that take place in particular contexts that are bound in time and space, rather than looking for universals that cut across large numbers of cultures. Research in this tradition tends to explore and describe detailed analyses of specific concrete activities that are present in a context – for example, documenting teaching and learning practices that a particular community engages in, such as how knowledge and skill are transmitted to the next generation of weavers in a weaving collective (see e.g., Cole, 1996; Rogoff et al., 1998). Research in this school is frequently situated, describing both patterns of behaviors and activities in a community, as well as variations in those behaviors and practices as a result of context. Thus, both stability and change are features of a micro-theoretic investigation, whereas macro-theories tend to focus on factors that are thought to be stable. Psychological processes that involve the production and reproduction of culture are relevant to this work, and in particular this approach includes a developmental psychology lens that examines the process of enculturation into a community through everyday activities. This culture-as-practice view is often in contrast to an approach in which culture can be positioned as a cause or an independent variable in a quasi-experimental cross-cultural study, which is more typical of macro-theories.

As an example of this culture-as-practice view, Rogoff et al (1998) have studied communities in which children are included in a wide range of adult activities as a regular part of everyday life. As they approach an appropriate developmental age to engage in adult practices, the expectation is that children begin to pay close attention to what adults in their community do. They learn new skills by making ever-increasing contributions to these on-going activities as they grow. This particular approach to integrating children into activities with a focus on learning community-relevant skills appears to be especially common in many Indigenous communities of the Americas (Lipka et al., 2005, 2007). In these communities, the goal of learning is not simply acquiring new skills or knowledge, but rather transforming one's participation in order to contribute and belong to the community. Accomplishing such transformation involves learning to collaborate with consideration and responsibility in strong coordination with other community members.

Some curricula designed on the basis of such micro-theories, and the practices and values of local communities, have been experimentally shown to lead to significantly higher learning gains for learners within the studied community. Lipka et al. (2005) designed, built and studied the effects of a culturally-focused mathematics curriculum over the course of many years with the Yup'ik indigenous community in Alaska. This curriculum resulted from continuously involving Yup'ik elders, teachers, and university researchers in its design. As a base, it incorporated community practices that required advanced mathematical skills such as fishing, building a kayak, and constructing a parka. Importantly. the design process revealed that community elders rely on geometric and spatial reasoning when performing these activities, as part of their traditional rituals and community practices. Beyond content, the curriculum also emphasized the incorporation of specific community norms, such as teaching only when children have actively chosen to participate and working towards common group goals rather than individual aims. In a number of studies, Lipka et al (2007) showed that students who were taught using this culturally focused curriculum significantly outperformed control groups within the community who were taught using the standard curriculum.

Limitations of micro-theories: Generalizability. While micro-theoretical approaches avoid the macro-theoretical trap of overgeneralizing from large groups to individuals, the major limitation of micro-theoretical approaches is whether findings generalize to other groups of learners at all. The application of micro-theoretical approaches runs into problems related to taking a completely situationalist view of context in learning (e.g. Cobb, 2002). In this paradigm, a specific context is considered only in terms of itself, rather than as emblematic of some contextual features that are general. While this may be a powerful approach for developing qualitative understanding of what occurred in one classroom or set of classrooms, one time, it may not contribute to developing general approaches or theories of learning that can benefit many students -- understanding their similarities as well as their differences. Taken to the extreme, this may result in models of learning only applicable for a single classroom, at one moment in time.

When incorporating a micro-theoretic perspective, there is a need to understand which future learners, contexts, and situations the findings can be safely applied to, and therefore, for what learners in which contexts a particular system is likely to be effective. Simply put, every time a study is run, it involves a certain set of learners with certain attributes. Some studies are small -- single classrooms (or even single students) drawn from a specific cultural context and setting. Other studies are very large, and involve a range of learners, as is seen in studies with MOOCs. Either way, however, we are left with a question of how findings generalize. Right now, the field's tools for determining where a finding applies are quite limited. For example, both student-level cross-validation (building a model on some students and testing on other students -- cf. Baker, 2018) and traditional methods for inferential statistics allow us to make predictions about new students drawn from the same population as the original students studied. However, these findings are limited to the specific population used. Group-level cross-validation (e.g. Ocumpaugh et al., 2014), sometimes called population-level cross-validation, allows us to make generalizations to students from groups drawn from the same population of groups used for the study as a whole. When generalization is successful under these conditions, this allows for more confidence than simply cross-validating at the student-level. Similar types of inference can be made for multi-level models in statistics. However, it is not always clear how to decompose a population into relevant and usable subgroups.

One attempt to address this limitation is seen in efforts such as the Generalizer project (https://www.thegeneralizer.org/), which looks at the similarity between the students being studied in a specific study and a broader national sample in the United States, in order to attempt to determine the representativeness of a sample relative to the overall population (Tipton, 2014). However, the variables that this approach considers to determine representativeness remain ad hoc, and it is not clear whether two schools considered similar under Tipton's method are similar in the fashions that most matter for this type of analysis. For example, while the proportion of African-American, Hispanic, White, English as a Second Language, and socio-economic status are included in the Generalizer (Tipton, 2014), categories such as Asian-American, Native American, urbanicity, and national region are not included. Despite the considerable effort put into developing the Generalizer project, the field's lack of knowledge of which variables matter most is a limiting factor to our confidence in generalization of findings.

As such, in order to begin leveraging a micro-theoretic approach to context and culture in CBL systems, several steps are necessary. We need to determine, as a field, which variables are most important; but even beyond that, we need to determine which contextual variables are relevant for which learning phenomena. It may be, for instance, that knowledge graphs (maps of how domain cognitive skills are inter-related) are influenced by curriculum standards (which would make national or state/provincial models appropriate), that engagement patterns are influenced by school culture factors, but that how affect is expressed is influenced most by community culture factors. In effect, we need efforts like the Generalizer, but in the context of a broader science of context that is specific and concrete. In the next section, we discuss what form these next steps might take.

Next Steps in the Development of Culturally-Responsive CBL

We see a need to take the following three steps to advance the science of developing a culturally-responsive CBL that can be used effectively at scale but which respects individuals' personal identity and is appropriate for the full diversity of learners:

1. Define an operationalization of culture.
2. Further develop theories of culture and context that are specific, precise, and actionable.
3. Determine how these theories can be used to inform intervention.

We describe these three challenges below, and steps that have been taken by the community to address them.

An Operationalization of Culture. While micro-theoretical approaches avoid the macro-theoretical trap of overgeneralizing from large groups to individuals, the major limitation of micro-theoretical approaches is whether findings generalize to other groups of learners at

As described above, a critical gap in existing theories is the focus on either high or low granularity when studying different groups. While most micro-theories of context pay attention to very fine-grained groups at particular moments in time, macro-theories (aside from the World Values Survey) typically focus on entire countries. An individual learner may have membership in multiple groups at any given time, and these groups may form a hierarchy with many levels between the individual and the country they live in, or they may intersect in complex ways (e.g. Crenshaw, 1991). There is thus a need for an operationalization or parameterization of culture at a meso-theoretic level that enables designers to tailor a design to an individual's group membership(s) but which can also provide a nuanced and specific perspective on what that group membership might entail. A brief list of variables that could be included in such a model might include: national group, subnational cultural group (ethnicity), subnational group (self-chosen group), religion, career or professional community (including, perhaps, family connections such as military-connected status), urbanicity, socioeconomic status (and its varied manifestations in different cultures), gender (and its many complex manifestations), and linguistic communities (including native language, heritage language participation, and second languages).

Some current approaches to modeling learners' culture represent an initial step with the potential to find this middle-level between macro and micro-theoretical approaches, such as Blanchard and Mizoguchi's (2008) work on using cultural ontologies to inform intelligent tutoring systems; Allard et al.'s (2008) work on using cultural ontologies to inform computer-assisted language learning systems; and Mohammed and Blanchard's (2015) work on designing a "heavyweight" ontology of culture to aggregate multiple cultural frameworks into a single ontology. These ontologies represent a medium level of specificity that might ultimately prove highly useful in meso-theoretical approaches to cultural modeling. One possible limitation is seen in Mohammed and Blanchard (2015), where they describe their ontology of culture as "captur[ing] the true essence of a domain". This approach to modeling culture follows from a positivist epistemology, and makes the risky assumption that cultural dimensions are stable, bounded constructs. Despite this assumption, these ontologies are also designed to be flexible, responsive to new information, and can be developed collaboratively with diverse and representative stakeholders, as with some of the micro-theoretic work discussed above.

Complicating this picture is the risk fact that it is likely to be insufficient to simply list out a set of contextual variables and then run a set of studies cleanly connecting each one to a set of outcomes. The contextual and individual variables we analyze are unlikely to separate cleanly; they are likely to correlate and interact with one another, but incompletely; religion and language may correlate, language and geographical region may correlate, and how learners view a domain may be wrapped up in a range of individual differences. More challenging yet, variables may be distinct from one another in some contexts but tied deeply to each other in other contexts. Moreso, the mapping of an individual to specific variables may be incomplete and situational; anyone who has experienced prejudice targeted towards themselves on the basis of a group membership that they do not even personally identify with recognize may realize that one's context is not wholly contained in one's self-views (Gee, 2000).

Thus, while these ontologies are a promising start, there are several questions that need to be resolved before they can be used most effectively. Are these ontologies even possible to define in a sufficiently exhaustive way, or do they become infeasible at scale due to the high level of detail? In addition, while Allard et al. acknowledge that these frameworks should be developed collaboratively, it is not clear who the collaborative partners should be, or how developers might solicit input from a sufficiently diverse and representative set of ontology designers, nor even how the leader of an initiative of this nature could determine what "sufficient" means in this context (given the multiplicity of intersectional identities discussed earlier).

Making Theory Actionable In order for theories of culture to be useful for designing and improving educational technologies, we put forward that they must be able to lead to insights that support making actionable predictions about what will be effective, efficient, and enjoyable for learners. In other words, we need to be able to apply our theories to real data and test how well they are working. Such a theory would have several criteria:

- *Make specific predictions when applied to data.* Data could be obtained from some learning context, whether online or offline, converted to a standard format, and input into a theoretical model. The model would yield predictions which could then be tested on the data. Across many data sets, the model could be refined - with efforts to ensure that revisions generated testable new predictions rather than over-fitting to a specific context (cf. Lakatos, 1970). By making specific predictions, aspects of the theory then become falsifiable; after several tests, the refined theory becomes usable as a source for adaptive instructional decisions.
- *Make computationally tractable predictions.* It would be necessary to be able to produce the predictions in a reasonable time-scale with an accessible degree of computational power, so that adaptive interventions can be implemented in real-time.
- *Make predictions that lead to better designs for learning and learning interaction.* This criteria applies whether the predictions drive automated intervention or simply support designers in developing better learning systems for the contexts they are working in. A theory of learning in context which does not support learning in context is ultimately inert.
- *Make predictions that are comprehensible to people.* A theoretical model that cannot be understood or explained does not serve as a good basis for pedagogical decision making, as it makes it impossible for learners and designers to reflect on the instructional design as it relates to their own personal progress, and denies learners agency in their own learning.

Right now education is rife with theories, models, and hypotheses that are treated as general but lack an effective way of knowing what contexts they work in. By making theory computationally tractable, and amassing the right data sets, we can scope our theory appropriately and have a better grasp of where more progress and enhancement is needed. It is worth noting that a great deal of scientific progress can be made, and has been made, without computational theory; but it is our view that by addressing this challenge we ultimately make it far more feasible to address all of the other challenges at hand.

From Operationalization to Intervention. Even with an actionable theory of culture, there will still be more work to do to understand how to move from theory to intervention. What is an appropriate way to identify the cultural context of a user? What is an appropriate granularity to serve as the basis for adaptive intervention (too coarse-grained, and the system does not properly adapt to the user; too fine-grained, and it may be impossible to design a system that adapts to all the cultural permutations)? And finally, how do interventions need to change based on culture? As Cole et al. (1996) notes, the efficacy of a particular learning technology may be shaped by how that technology engages with and is designed for particular culture of learners. But understanding exactly how may be challenging.

One example of a possible way forward is to develop multiple versions of an application for different cultural contexts. For example, Munro-Smith (2003) created four versions of their system, with each version designed for learners from an intersection of Hofstede-inspired dimensions (e.g., one version for a collectivist, high power distance, high uncertainty avoidance culture). A second approach is to allow users multiple paths through the same system based on the cultural context with which they feel most comfortable. For example, Henderson et al. (1996) proposed a model where a learning system might hide, display, or modify elements of the learning experience, based on navigation of the interface. Such a user-driven approach may account for the dynamism of these cultural factors because a learner can choose the experience they want at any given point in time.

To avoid the limitations of the researcher, developer, or another outsider ascribing a category to a particular user, it may be reasonable to allow the users themselves to choose either the parameters they would use to identify themselves or to choose the interactions they wish to experience within a particular system. For example, Mohammed and Mohan (2015) provided students with a slider that allowed them to select the level of "cultural density" used in a system. They then implemented this contextual student model into a "Culturally Relevant Intelligent Tutoring System" (CRITS), which incorporated culturally relevant objects and culturally-inflected language into a computer science tutoring system's content (Mohammed & Mohan, 2015), to the degree specified by the students. A previous version of the system (Mohammed & Mohan, 2013) had used a "contextual user model", with an ontology of 24 factors of users' context, including personal factors (age, gender, country of birth, region

where the student lives, etc), personal influences (language, religion, etc), and factors of the students' parents (e.g. religion, language, etc) which were weighted to produce a score of affiliation to a particular contextual group. While students learned significantly more with the fully enculturated system, CRITS was proposed as a way to accommodate a set of learners who felt that the high cultural density of the language made their progress more difficult. Offering students a choice of the degree of cultural adaptation represented a way of providing students with agency and control over their learning experience.

In sum, we need to make progress towards better understanding what the meaningful contextual, cultural, and personal attributes are; how these attributes interact (and can combine or blend at the edges); which attributes are meaningful for which questions; and finally then we can answer the question of how these attributes are predictive of differences in educational processes, outcomes, and ultimately which designs are appropriate and effective.

Author Context

Because of the importance of researchers' cultural perspectives in shaping the direction of their research and the learning systems they design, we feel that it is important for us to acknowledge our own particular cultural perspectives and contexts. While we feel it is important for researchers to acknowledge their own cultural backgrounds, it may be uncomfortable, difficult, or even dangerous for researchers in some contexts to do so, if such disclosure may cause them personal or professional harm. It should always be a researcher's choice to decide what aspects of their identity they wish to disclose in a professional setting. The authors of this paper grew up in different contexts within the same region of the world, and our perspectives have been shaped by the contexts we have lived in. Baker grew up in suburbs in the Midwestern US and Texas, and has lived in multiple areas within the Northeastern US, Midlands England, and Denmark, as well as routinely spending extended time in Northeastern Brazil over a span of several years. Ogan is a white female raised in a rural area of the Mid-Atlantic US, spending extended time in Southern Europe, South America, and East Africa. Madaio is a queer white male who grew up in the Mid-Atlantic US, in the suburbs of a mid-sized city. Walker is a white female who grew up in a city in the Canadian Prairies.

While collectively we have conducted research in a range of sites in worldwide contexts, we have been heavily reliant on our partnership working with researchers in other contexts as full partners and often leaders of the research. Collectively, our collaborators who are more familiar with local conditions and values have helped define research questions and understand the data, and have been full (and often first) authors of conference and journal papers.

Conclusion

In this article, we have considered some of the current limitations of research on computer-based learning, focusing on ways that it has not fully addressed cultural and contextual issues. These limitations prevent current-generation technology from being fully responsive to the needs of the full diversity of learners. A key limitation to existing research comes from the theoretical paradigms available to researchers. Existing macro-theories define individuals in overly broad terms, and micro-theoretical work often does not sufficiently consider issues of generalizability to drive broadly usable design.

We discuss possible steps forward that can be used to operationalize culture and make theory concrete and actionable. By identifying the key cultural variables in a particular learning environment we can improve the personalization of the experience beyond what is currently available. This may involve presenting users with multiple versions of an application or multiple paths through an application, or more generally, creating a more detailed parameterization of culture-related variables. It is important to note that deciding among these approaches to cultural adaptivity may necessitate making a tradeoff between learner fit (how adaptive the system can be to a particular learner) and the scalability of the system.

It is important to acknowledge that the above call-to-arms represents an ambitious research agenda that may not be fully attainable. It may be impossible for researchers and designers of computer-based learning systems (or anyone) to define every single cultural factor, or to automatically categorize learners' multifarious, intersectional cultural identities with sufficient accuracy. Indeed, it is a thorny epistemological question whether it is even possible to classify or identify culture at all. This challenge illustrates the importance of offering learners choice and agency over their own learning experiences. There may be cases where it will be essential to allow learners to self-identify various salient aspects of their culture or select their own path through a technology-based intervention. However, it is important to note that there may be cases where users' identification with a particular culture or group may be

directly harmful and should be avoided, as in LGBT learners exposing themselves to violence or stigma if they are "outed" by a learning technology.

As we go forward in pursuing this agenda, those of us who are based in contexts traditionally represented in computer-based learning research should always be cognizant of the importance of working with researchers closely connected to the contexts being studied, a recommendation perhaps best articulated by Tuhiwai Smith (1993). It is extremely easy for an outsider to misinterpret data that emerge in an unfamiliar context; the result can be theories and conclusions that are inaccurate, or even perpetuate or reinforce existing inequities. Research in developing and underrepresented contexts must be driven by the questions and concerns of researchers based in those contexts, with external researchers acting as a methodological "force multiplier" and support.

This leads to a final key point. Although we have referred to the idea of a culturally based curriculum and pedagogy, as well as theory, these are, in fact, misnomers. All curricula and theories are culturally based. There is no neutral context; all researchers and curricula come from somewhere. The key question when looking at a curriculum, a pedagogy, or a theory is, on whose culture is it based? In many indigenous contexts, curriculum has been based on and imposed by the majority culture (Deyhle & Swisher, 1997). Our community of researchers has the opportunity to avoid repeating this pattern in the future of computer-based learning; as a community, we have the opportunity to create theory and systems that are more broadly appropriate and thereby more effective at achieving their goals.

We do not envision that efforts to create next-generation theory will be easy, or that they will be completed in one step. However, we hope that the establishment of the journal this article is published in, Computer-Based Learning in Context, will provide a venue not just for direct steps towards theory, but also for publication on the types of empirical research in this area that have often proven difficult to publish in existing venues. Through creating a home for rigorous empirical work on how computer-based learning differs between contexts, along with a venue for work towards productive theory in this area, we hope to move forward the discourse around how learning technologies can be made effective and appropriate for all of the world's learners.

References

Allard, D., Bourdeau, J., & Mizoguchi, R. (2008). Towards modeling knowledge of cultural differences and crosslinguistic influence in Computer-Assisted Language Learning (CALL). In E. Blanchard & D. Allard, *Proceedings of the Culturally Aware Tutoring Systems (CATS) Workshop, ITS Conference* (pp. 11-22).

Baker, R.S. (2018) *Big Data and Education, 4th Edition*. Philadelphia, PA: University of Pennsylvania.

Baker, R.S.J.d., Gowda, S.M. (2010) An Analysis of the Differences in the Frequency of Students' Disengagement in Urban, Rural, and Suburban High Schools. *Proceedings of the 3rd International Conference on Educational Data Mining*, 11-20.

Baker, R.S., Ocumpaugh, J.L., Andres, J.M.A. (in press) BROMP Quantitative Field Observations: A Review. To appear in Feldman, R. *(Ed.) Learning Science: Theory, Research, and Practice*. New York, NY: McGraw-Hill.

Baskerville, R. F. (2003). Hofstede never studied culture. *Accounting, Organizations and Society*, 28(1), 1-14.

Baskerville-Morley, R. F. (2005). A research note: the unfinished business of culture. *Accounting, Organizations and Society*, 30(4), 389-391.

Blanchard, E. G., & Mizoguchi, R. (2008). Designing culturally-aware tutoring systems: towards an upper ontology of culture. In *Proceedings of the Workshop on Culturally Aware Tutoring Systems (CATS),* 23-34.

Blyth, C. R. (1972). On Simpson's paradox and the sure-thing principle. *Journal of the American Statistical Association*, 67(338), 364-366.

Buolamwini, J., & Gebru, T. (2018, January). Gender shades: Intersectional accuracy disparities in commercial gender classification. *In Conference on Fairness, Accountability and Transparency* (pp. 77-91).

Byun, S. Y., Meece, J. L., & Irvin, M. J. (2012). Rural-nonrural disparities in postsecondary educational attainment revisited. *American Educational Research Journal*, 49(3), 412-437.

Cassell, J. (2009, July). Social practice: Becoming enculturated in human-computer interaction. *In International Conference on Universal Access in Human-Computer Interaction* (pp. 303-313). Springer, Berlin, Heidelberg.

Chase, C.I., Mueller, D.J. (1989) Off task behavior: An American loss to the Japanese. *Journal of Human Behavior and Learning*, 6 (1), 19-21.

Cobb, P. (2002). Situating mathematical learning in the social context of classroom mathematical practices. Paper presented at the annual meeting of the *American Educational Research Association*, New Orleans.

Cole M,. Gay J., Glick, J.A. & Sharp, D. W. (1971) *The cultural context of learning and thinking: an exploration in experimental anthropology.* New York: *Basic Books*. p. 295.

Conn, Katharine M. (2017) Identifying effective education interventions in sub-Saharan Africa: A meta-analysis of impact evaluations. *Review of Educational Research,* 87, 863-898.

Crenshaw, K. (1990). Mapping the margins: Intersectionality, identity politics, and violence against women of color. *Stanford Law Review,* 43, 1241.

Deyhle, D., & Swisher, K. (1997). Chapter 3: research in American Indian and Alaska Native education: from assimilation to self-determination. *Review of Research in Education*, 22(1), 113-194.

Edmondson, J., & Butler, T. (2010). Teaching school in rural America: Toward an educated hope. In Schafft, K.A., Jackson, A.Y. (Eds.) *Rural education for the twenty-first century: Identity, place, and community in a globalizing world,* 150-172.

Fisher, A. J., Medaglia, J. D., & Jeronimus, B. F. (2018). Lack of group-to-individual generalizability is a threat to human subjects research. *Proceedings of the National Academy of Sciences*, 115(27), E6106-E6115.

Fiske, J. (1992) Cultural Studies and the Culture of Everyday Life. In L. Grossberg, C. Nelson, P.A. Treichler (Eds.) *Cultural Studies* (pp. 154-173). New York, NY: Routledge Press.

Frambach, J. M., Driessen, E. W., Beh, P., & Van der Vleuten, C. P. (2014). Quiet or questioning? Students' discussion behaviors in student-centered education across cultures. *Studies in Higher Education*, 39(6), 1001-1021.

Gay, G. (2010). *Culturally responsive teaching: Theory, research, and practice.* New York, NY: Teachers College Press.

Gee, J. P. (2000). Identity as an analytic lens for research in education. *Review of Research in Education*, 25(1), 99-125.

Gerhart, B., & Fang, M. (2005). National culture and human resource management: assumptions and evidence. *The International Journal of Human Resource Management,* 16(6), 971-986.

Henderson, L. (1996). Instructional design of interactive multimedia: A cultural critique. *Educational Technology Research and Development,* 44(4), 85-104.

Hofstede, G. (1986). Cultural differences in teaching and learning. *International Journal of Intercultural Relations,* 10(3), 301-320

Hofstede, Geert (1991). *Cultures and organizations : software of the mind.* London: McGraw-Hill.

Hofstede, G. (2011). Dimensionalizing cultures: The Hofstede model in context. *Online Readings in Psychology and Culture, 2*(1), 8.

Hofstede, G., & Bond, M. H. (1984). Hofstede's culture dimensions: An independent validation using Rokeach's value survey. *Journal of Cross-Cultural Psychology, 15*(4), 417-433.

House, R. J., Hanges, P. J., Javidan, M., Dorfman, P. W., & Gupta, V. (Eds.). (2004). *Culture, leadership, and organizations: The GLOBE study of 62 societies*. Thousand Oaks, CA: Sage Publications.

Huang, X., Craig, S. D., Xie, J., Graesser, A., & Hu, X. (2016). Intelligent tutoring systems work as a math gap reducer in 6th grade after-school program. *Learning and Individual Differences*, 47, 258-265.

Inglehart, R., & Welzel, C. (2010). Changing mass priorities: The link between modernization and democracy. *Perspectives on Politics*, 8(2), 551-567

Kizilcec, R. F., & Cohen, G. L. (2017). Eight-minute self-regulation intervention raises educational attainment at scale in individualist but not collectivist cultures. *Proceedings of the National Academy of Sciences*, 114(17), 4348-4353.

Knorr-Cetina, K. D. (1988). The micro-social order: towards a reconception. In N. G. Fielding (Ed.), *Actions and Structure: Research Methods and Social Theory.* London, UK: Sage, pp. 21-53.

Kulik, J. A., & Fletcher, J. D. (2016). Effectiveness of intelligent tutoring systems: a meta-analytic review. *Review of Educational Research*, 86(1), 42-78.

Kumar, A., Tewari, A., Shroff, G., Chittamuru, D., Kam, M., & Canny, J. (2010, April). An exploratory study of unsupervised mobile learning in rural India. *In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 743-752). ACM.

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal,* 32(3), 465-491.

Lakatos, I. (1970). Falsification and the methodology of scientific research programmes. In Lakatos, I., Musgrave, A. (Eds.) *Criticism and the Growth of Knowledge*, 4, 91-196. Cambridge, UK: Cambridge University Press.

Lan, X., Ponitz, C. C., Miller, K. F., Li, S., Cortina, K., Perry, M., & Fang, G. (2009). Keeping their attention: Classroom practices associated with behavioral engagement in first grade mathematics classes in China and the United States. *Early Childhood Research Quarterly*, 24(2), 198-211.

McSweeney, B. (2002). The essentials of scholarship: A reply to Geert Hofstede. *Human Relations*, 55(11), 1363-1372.

McSweeney, B. (2013). Fashion founded on a flaw: The ecological mono-deterministic fallacy of Hofstede, GLOBE, and followers. *International Marketing Review, 30*(5), 483-504.

Mittelmeier, J., Heliot, Y., Rienties, B., & Whitelock, D. (2015). The Role Culture and Personality Play in an Authentic Online Group Learning Experience. In: *Proceedings of the 22nd EDINEB Conference: Critically Questioning Educational Innovation in Economics and Business: Human Interaction in a Virtualising World*, 139-149. Brighton, UK.

Mohammed, P., & Blanchard, E. G. (2015). Leveraging comparisons between cultural frameworks: preliminary investigations of the mauoc ontological ecology. *In Sixth International Workshop on Culturally-Aware Tutoring Systems* (CATS2015) (p. 1).

Mohammed, P., & Mohan, P. (2013). Contextualised student modelling for enculturated systems. In *AIED 2013 Workshops Proceedings Volume 5* (p. 20).

Mohammed, P., & Mohan, P. (2015). Dynamic cultural contextualisation of educational content in intelligent learning environments using ICON. *International Journal of Artificial Intelligence in Education*, 25(2), 249-270.

Munro-Smith, N. (2003). A culturally aware course design. *Proceedings of the 2013 ASCIILITE Conference.*

Ocumpaugh, J., Baker, R., Gowda, S., Heffernan, N., Heffernan, C. (2014) Population validity for Educational Data Mining models: A case study in affect detection. *British Journal of Educational Technology*, 45 (3), 487-501.

Ogan, A., Walker, E., Baker, R.S.J.d., de Carvalho, A., Laurentino, T., Rebolledo-Mendez, G., Castro, M.J. (2012) Collaboration in Cognitive Tutor Use in Latin America: Field Study and Design Recommendations. *Proceedings of ACM SIGCHI: Computer-Human Interaction*, 1381-1390.

Ogan, A., Walker, E., Baker, R., Rodrigo, M.M.T., Soriano, J.C., Castro, M.J. (2015) Towards Understanding How to Assess Help-Seeking Behavior Across Cultures. *International Journal of Artificial Intelligence in Education*, 25 (2), 229-248.

Popov, V., Noroozi, O., Barrett, J. B., Biemans, H. J., Teasley, S. D., Slof, B., & Mulder, M. (2014). Perceptions and experiences of, and outcomes for, university students in culturally diversified dyads in a computer-supported collaborative learning environment. *Computers in Human Behavior, 32,* 186-200.

Rodrigo, M. M. T., Baker, R. S. J. D., & Rossi, L. (2013). Student off-task behavior in computer-based learning in the Philippines: comparison to prior research in the USA. *Teachers College Record*, *115*(10), 1-27.

Rodrigo, M. M. T., Sugay, J. O., Agapito, J., & Reyes, J. R. S. (2014). Challenges to transferring western field research materials and methods to a developing world context. *Research and Practice in Technology Enhanced Learning*, *9*(1), 71-82.

Rogoff, B., Matusov, E., & White, C. (1998). Models of teaching and learning: Participation in a community of learners. In Olson, D.R., Torrance, N. (Eds.) *The Handbook of Education and Human Development*, 388-414.

Schofield, J. W. (1995). *Computers and classroom culture.* Cambridge, UK: Cambridge University Press.

Skrypnyk, O., Hennis, T. A., & Vries, P. D. (2014). Understanding social learning behaviours of xMOOC completers. *In Proceedings of SEFI Annual Conference*.

Thayer, K., Guo, P. J., & Reinecke, K. (2018). The Impact of Culture on Learner Behavior in Visual Debuggers. *In 2018 IEEE Symposium on Visual Languages and Human-Centric Computing* (VL/HCC) (pp. 115-124). IEEE.

Tipton, E. (2014). How generalizable is your experiment? An index for comparing experimental samples and populations. *Journal of Educational and Behavioral Statistics*, 39(6), 478-501.

Trompenaars, F., & Hampden-Turner, C. (2011). *Riding the waves of culture: Understanding diversity in global business.* London, UK: Nicholas Brealey International.

Tuhiwai Smith, L. (2013). *Decolonizing Methodologies: Research and Indigenous Peoples.* Auckland, NZ: Zed Books Ltd..

Van de Vijver, F. J., & Poortinga, Y. H. (2002). Structural equivalence in multilevel research. *Journal of Cross-Cultural Psychology*, *33*(2), 141-156.

Venaik, S., & Brewer, P. (2008). Contradictions in national culture: Hofstede vs GLOBE. In *Proceedings of the Academy of International Business 2008 Annual Meeting*,

Weisz, J.R., Chaiyasit, W., Weiss, B., Eastman, K.L., Jackson, E.W. (1995) A multimethod study of problem behavior among Thai and American children in school: teacher reports versus direct observation. *Child Development*, 66 (2), 402-415.