POLYCULTURAL APPROACHES FOR CENTERING DIVERSITY AS A RESOURCE: THE CASE OF SOCIAL DESIGN-BASED EXPERIMENTS

Emmanuel Nti-Asante
Florida International University
entia001@fiu.edu

The growing diverse nature of our STEM spaces has informed education experts to recommend use social-design-based experiments (SDBE) to design teaching-learning curriculum that frames these diversities as a resource. This call for SDBEs comes from identified challenges in existing approaches like funds of knowledge and identity. However, there is a need for a conceptual lens that educators will use to actualize this essential call in Mathematics Education. Given this, I use this proposal to explore existing approaches and their challenges to addressing diversity as a resource. I continue to develop a conceptual lens for teachers to follow in their operationalization of SDBE to design a teaching-learning curriculum that centers diversity as a resource. This conceptual lens comprises a five-phase participatory perspective and relationship to curriculum planning, designing, and enactment where teachers and students co-participate.

Keywords: Equity, Inclusion, and Diversity, Instructional Activities and Practices, Learning Theory

Problem

Today, the mathematics classroom is diverse; we have many races, gender, color, ethnic groups, languages, and others. As the renowned socio-culturalist Michael Cole (1998) put it, there are two ways to deal with this diversity: make it disappear or use it as a resource (Gutiérrez et al., 2009, p.216). As shown in Figure 1, Cole (1998) reported emergent approaches like "English-only or Bilingual Education" by researchers and policymakers as an attempt to make diversity in terms of multilingual education disappear. In line with these policies in making diversity disappear, "mathematics education generates selection, exclusion and segregation" of students along the lines of gender, race, language, and socioeconomic status (Skovsmose & Valero, 2001, p. 41 cited in Foote & Bartell, 2011, p.45). On the contrary, seminal researchers researching diversity as a resource, like Hewlett et al. (2013), used their article "How-Diversity-Drives-Innovation" to detail how more diverse groups result in innovation. Thus far, researchers have developed polycultural approaches for attaining diversity as a resource (Civil, 2007; Cole, 1998; DiME, 2007; Nasir & Cobb, 2007; Adler, 2000; Trouche, et al., 2023). Cole (1998) used Figure 1 to summarize major polycultural approaches from Cultural Psychology that these researchers have used to approach diversity as a resource.

Among these polycultural approaches, much literature exists on how mathematics educators approach diversity as a resource through the funds of knowledge approach (González, et al., 2001; Hogg, 2011) and interpretive communities (Civil & Planas, 2012). In this proposal, I conceptualize how educators can use one emergent polycultural approach, Social Design Based Experiments (SDBE), to design teaching-learning curricula where they establish and incorporate diversity as a resource. I answer the research question; What are some conceptual lenses and their accompanying SDBE methodologies that can help researchers design teaching learning curricula where they establish and incorporate diversity as a resource?

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In this proposal, diversity as a resource is a situation whereby policymakers and educators use polycultural approaches to rigorously study and establish the opportunity provided by the rich resources and reciprocal relations of exchange these diverse groups bring to interact in the multicultural classroom (Cole, 1998). These Polycultural approaches, useful for attaining diversity as a resource, refer to "the strategies that help educators and policymakers to recognize, establish and capitalize on the fact that multiple cultures are present in every classroom and that wherever culture-using creatures interact, they create between them a hybrid subculture, appropriate to the activities it mediates" (Cole, 1998, p.300). This hybrid subculture takes an approach that resists home and school binaries and formal and informal learning like bilingual education where students blend English with that of their home language. Instead, it focuses on what takes hold as children and youth move in and across their everyday lives in various settings and contexts (Tuomi-Gröhn & Engeström, 2003). This approach allows for identifying both possibilities and constraints within and across contexts (Cole & Engeström, 1993) where we can capitalize on the understanding of diversity as a resource through cultural dimensions of learning and development (cultural psychology) occurring as "people, ideas, and practices of different communities meet, collide, and merge" (Engeström, 2005, p. 46) to capitalize on the understanding of diversity as a result through cultural dimension of learning and development (cultural psychology).

In the remaining sections of this proposal, I provide a snapshot of the two predominant polycultural approaches in Mathematics Education. I continue with the theoretical and methodological conceptualization of SDBEs. I conclude the proposal with a call for studies where researchers operationalize the conceptualization.

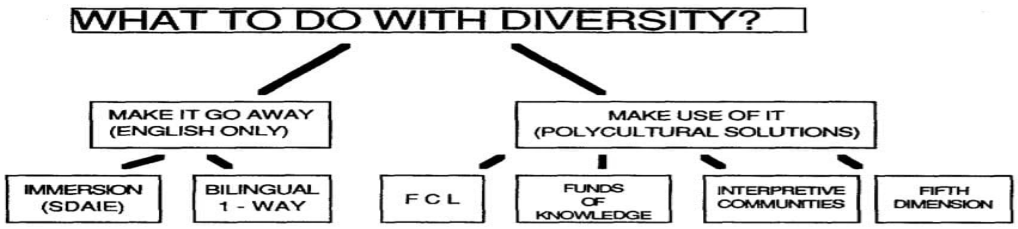

Figure 1: Polycultural Approaches

Polycultural Approaches for Centering Diversity as a Resource in Mathematics Education

Adler (2000) provided a comprehensive literature review and reconceptualization of how mathematics educators define resources. She stated that the common-sense notion of resources in and for education focuses on basic material and human resources. The basic material and human resources include the physical infrastructure in the school, like the buildings and teacher-pupil ratios or class size, and teacher qualifications, respectively (Adler, 2000). Adler argues for a provocative turn where researchers draw attention to resources and their use to question such taken-for-granted meanings. Thus, as a first conceptualization of resource in this study, Adler advocates researchers should consider resource as a verb and action (re-source) that would mean to source again or differently where they look beyond material objects and include human and cultural resources such as language and everyday practices as pivotal in school mathematical practice (Adler, 2000).

Cultural psychology and anthropology researchers have conceptualized polycultural approaches like funds of knowledge to attain this re-source. The term "funds of knowledge" refers to the historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being (Tapia, 1991, cited in Moll et al., 1992, p.133). In the funds of knowledge re-source project in mathematics education, the project Bridge, Civil (1994) stated that the project aimed to develop mathematics teaching innovations in which students and teachers engage in mathematically rich situations by creating learning modules that capitalize on students (and their families) knowledge and experiences in their everyday life. They reject a deficit theory model like approaches that foster disappearing of diversity for the mathematics education of students from non-dominant communities to take the sociocultural approach to education where they center it as a resource. In this approach, their research goal and questions relied on the components of the four vital interrelated models: *Household Ethnographic Analysis; Teacher-Researcher Study Groups; Classroom Implementation, and Parents as Learning* Resources (Civil, 1994, p.6). In Civil (1994), she stated that their work occurs mainly in classrooms where most Mexican students are economically disadvantaged. For example, Civil and Andrade (2002b) studied Hispanic households they visited to identify their use of mathematics, mainly in sewing and gardening.

Using a second polycultural approach to inquiry, an interpretive and critical approach, Planas and Civil (2013) provided a comprehensive literature review on how researchers approach language-as-resource. They defined this critical and interpretive to include researchers' and policy-makers attendance to diversity as a resource by encouraging mathematical participation, assuming that "all students have valuable knowledge and experiences to contribute to a mathematics discussion" (Planas & Civil, 2013, p. 366). Contrary to the English-only approach, Planas and Civil interpreted data from their two studies conducted in multilingual classrooms from Mexico and Catalan to argue that the presence of different languages in the mathematics classroom is a potential for thinking and doing, and more particularly for learning and teaching mathematics.

Challenges and Responses to the Operationalization of the Polycultural Approaches

Challenges

Although these polycultural approaches have helped the mathematics education community come close to understanding diversity as a re-source, they bore the challenges that emergent approaches like SDBEs, under-conceptualized in mathematics education research, are addressing. Civil (1994) outlined some of the challenges in Project Bridge, including their fuzzy approach. Thus, they need an exemplary curriculum they could explore together or a series of activities on a specific topic in mathematics. Adler (2000) suggested a shift from these approaches that help us to "broaden a view of what such resources are to how resources function as an extension of the mathematics teacher in the teaching-learning process" p.207. Other researchers have called for the role of the student in designing the funds of knowledge. Esteban-Guitart (2021) argued that the funds of knowledge approach centers on adults and the familial practices of these students to leave out that of the students. Other challenges Esteban-Guitart (2021) identified include challenges with ethnography like timezone and cultural restrictions to researchers, and inadequate time to gather all the funds of knowledge of all learners. Concerning the interpretive approaches, Cole (1998) highlighted the need for macro impacts of such projects beyond the context.

Response

Individual researchers have responded to their identified problems with each polycultural approach. Building from their premise, Esteban-Guitart and Moll (2014) conceptualized the funds of identity construct. They used Funds of identity "to refer to the historically accumulated,

culturally developed, and socially distributed resources essential for a person's self-definition, self-expression, and self-understanding" (Esteban-Guitart & Moll, 2014, p.168). In this approach, they incorporate "identity artifacts" to overcome the challenges of ethnographic studies in the funds of knowledge approach. These identity artifacts are "documents created by the learners about themselves, in which they try to capture all the things that make sense and are meaningful to them and which, subsequently, can be used by teachers to work on curricular and pedagogical content" (Subero et al., 2018, p. 156 cited in Esteban-Guitart, 2021, p.169). Concerning Adler's call for focusing on how these resources function as an extension of the mathematics teacher in the teaching-learning process, Remillard (2005) theorized a participatory relationship and perspective to curriculum development. As used in this study, they stated that "curriculum materials refers to a set of materials designed to guide a program of instruction and student learning over time (Pepin et al., 2017b cited in Trouche et al. 2023, p.504). Contrary to canonical characterizations of curricula materials to be textbooks and technological tools, Trouche and colleagues considered curricula materials to include designed artifacts, having both visible and ideational components that bring attention to the variety of forms and languages of communication they embody and how they encode cultural messages. Wartofsky (1979) referred to these artifacts as tertiary artifacts. Hence, going forward, I will use curriculum and tertiary artifacts or artifacts to mean the same as this definition. In the development of these curriculum materials, the teacher co-participates in the designing process to bring their expertise, like teacher mathematical perceptions of curriculum, and pedagogical and mathematical knowledge, to identify which resources encapsulate the collective evolution of the teacher's expertise and intention for the planned curriculum (Trouche et al., 2023). They used this participatory perspective to offer "a second reconceptualized notion of resources used in this study and also in teaching to also include the human, ideational, linguistic, and discursive practices that mediate teacher-students' interactions with their planned and enacted curriculum, particularly in contexts where access to material resources is constrained" (Trouche, et al., 2023, p. 506). Trouche and colleagues stated that while enacting this planned curriculum, the participatory view assumes that teachers' use of the curriculum materials requires the teacher to consider how the encapsulated resource fosters teacher-student-context dialectical and mediational interactions.

New Directions to Addressing the Challenges

Although these individual researchers have responded to their identified challenges with profound polycultural approaches in Mathematics Education, much remains. Esteban-Guitart (2021) referenced two studies that documented all the funds of the identity of all students, he stated that " we need procedures that could take into account and incorporate the funds of knowledge and identity of all the learners" p.169. Researchers need a conceptualization that incorporates Civil's (1994), and Cole's (1998) query of the funds of the knowledge and interpretive approaches stated above. Also, we would want the re-sources either from the familial practices of these students, based on the student's identities be a central part of the teaching-learning activities or the curriculum; what remains in most of the approaches above is how exactly how these re-sources are re-sourcing the field (extending the field to new frontiers or solving a longstanding educational problem for collective advancement of the practice). More profoundly, needful is an approach that brings all these patches of responses together and attends to the existing challenges in the funds of knowledge approach. Nazir et al., (2021) recommended SDBEs as a possible polycultural approach that reorganizes and incorporates other challenges in existing polycltural approaches to establish diversity as a resource. In the remaining sections of this proposal, I explore how Social-Design Based Experiments (SDBE) serve as this needful approach.

Towards Social Design-Based Experiments

In this section I describe SDBEs, their theoretical and methodological stance.

What are SDBEs?

Social Design-Based Experiments (SDBEs) involve proleptic forms of design organized around a utopian ideal and methodology (Brown & Cole, 2001; Levitas, 2013)—that is, imagining and designing an ideal ecology and outcome (Gutierrez et al.,2020, p.331). In line with centering diversity as a resource, Gutierrez and colleagues stated that;

> the impetus for SDBEs was motivated by a desire for educational justice in environments and communities of interest in which learning for youth from non-dominant communities could become meaningful and consequential, expanding their social futures (p.333).

As a possibility to overcoming challenges in existing polycultural approaches, SDBEs are an advanced approach to design research organized around a commitment to transforming the educational and social injustices faced by non-dominant communities to boost social equity and learning (Gutierrez & Jurow, 2016).

Theoretical Perspectives of SDBEs

Theoretically, SDBEs take a historicized, ecological approach and focus on people's everyday practices as a productive unit of analysis for understanding human activity and the learning therein (Gutiérrez et al., 2017).

> They are situated within the increasing field of contemporary educational sociocultural theories (Atweh, Forgasz, & Nebres, 2001; Bartolini Bussi & Mariotti, 2008; Cantoral, 2013; Lave, 1988; Lave & Wenger, 1991; Sfard, 2008; Saxe, 2012; Stetsenko, 2017) that are profoundly intertwining cultures and what their individuals think, do, feel, imagine, hope and dream (Radford, 2021, p.27).

Radford stated they take inspiration from the works of Hegel, Marx's philosophies, the seminal work of L.S. Vygotsky and collaborators, and Freire's concept of education. Its goal is in twofold;

1. to offer a precise theoretical conception of learning as a genuine collective agentic cultural-historical process
2. to explore the practical pedagogical conditions that make genuine collective learning possible (Radford, 2021, p. xi).

Radford added that SDBE researchers draw on the work of Vygotsky and Freire to offer a theoretical perspective that changes classrooms into sites of communal life where students make the experience of ethics of solidarity, responsibility, plurality, and inclusivity (Radford, 2021). Radford stated that;

> this theoretical stance they operate posits the goal of education in general, and mathematics education, as a political, societal, historical, and cultural endeavor aimed at the dialectical creation of reflexive and ethical subjects (poetic) who critically position themselves in historically and culturally constituted mathematical discourses and practices, and who ponder new possibilities of action and thinking (psoesis) p.36.

Methods for Designing SDBEs

I use this section to describe the methods of designing SDBEs. These methods double as a conceptual lens to designing SDBEs teaching-learning curriculum. Methodologically, SDBE combines divergent and new solutions to identified problems in the funds of knowledge approach

to operationalize them chronologically as one. In the first phase, owing to Civil's (1994) identification of the fuzzy nature of the approach to designing for funds of knowledge, designing for SDBEs involves identifying an educational problem and taking a historical-ecological stance to inquiry as a lens to design. Thus, taking a participatory perspective to the planned curriculum discussed above, teachers deploy their expertise to identify through review of literature and survey methods to provide students with themes comprising findings from students' learning ecologies like; their funds of identity like games they play, religious and other cultural practices, personalization's like their future career (Walkington, 2012), funds of knowledge like their familial and parental occupation. For example, teachers might review literature on concepts students struggle with, they evaluate students' conceptions of this mathematical concept to identify peculiar struggles students have. They use political-historical methods to explore the historical developments of the concepts. Lastly, they engage students to identify their varying learning ecologies and a characterization of learning from the SDBE perspective by Nazir and colleagues (2021) as shown in Figure 2. These findings serve as themes for the second phase of the design.

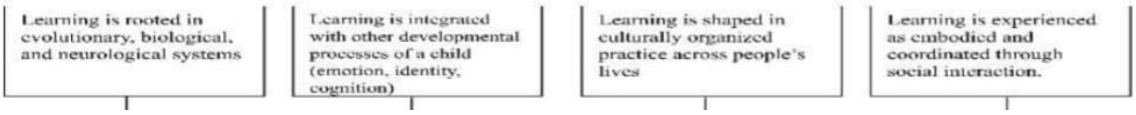

Figure 2: Some Description of Learning from SDBE Perspective useful as a Lens to Design

In the second phase, teachers position all students as subjects who can see historically to transform their socio-historical circumstances and futures as learners and agents of social change. (Gutierrez et al., 2017). Hence, teachers employ extended case study methods (Burawoy,1998), to engage students to identify the helpful artifact encapsulating the abovementioned themes. This helps us overcome challenges identified in the funds of identity approach where the struggle exists to identify all students' funds of identity or knowledge. It is at this point that students must search for an artifact from their community that encapsulates these themes that I consider the essential role of a multicultural classroom where we can establish diversity as a re-source. Thus, a third conceptualization of resource, where students from diverse backgrounds rather than a homogenous community in this multicultural classroom provide access to possible and variants artifacts. Hypothetically, searching for these historico-ecological artifactual constructs requires mostly students and practices from non-dominant groups and under-resourced environments.

In the third phase of the SDBE, students bring written narratives and images of their identified artifacts to school. Teachers, designers, and students take a participatory perspective to curricula design where they co-participate through joint activity to develop the curriculum which is the identified artifact into an enacted curriculum useful to all. Contrary to the funds of identity construct "identity artifact" this artifact is tertiary artifact and a full curriculum which holds possibilities beyond developing students' identity to bring transformative praxis to the academy. The artifact is tertiary, thus an 'imaginary' artifact that has 'lost' its original role of representation since students often write its descriptions to become "abstracted from its use in productive praxis" and its "direct representational function" (Warsofsky, 1979, p.45). Engestrom (1990) describes them as the 'Where-to' artifacts since they hold visions of the future.

Learning from this SDBE perspective is considered as that of learning as a movement construct. Thus, students learn when they develop and engage with tertiary artifacts that historical

actors (teachers, students, and designers) develop to identify timescales, learning ecologies and possible futures (Gutiérrez & Jurow, 2016; Nasir et al., 2021). The meaning of context is metaphorical because SDBE researchers limit the concept of context to descriptions of the written and spoken word. This is the Vygotskian perspective of context which leads us to an understanding of ecology as interwoven and "actively achieved" (Cole, 1996, p. 134), "like tangled roots" (Packer, 2010, p. 24) through texts, rather than concentric circles (Gutiérrez, 2016)" p. 42. Hence, movement is a form of student objectification and subjectification's as they set encapsulated text into motion. Radford (2002) defines *objectification processes* as students gradually becoming acquainted with historically constituted cultural meanings and forms of reasoning and action by metaphorically setting encapsulated texts in motion. Thus, the objectification processes entail a moment of poēsis: a moment of "bringing forth" something to the realm of attention and understanding through a creative moment of disclosure–the event of the thing in consciousness (Radford, 2010). These processes of objectification and subjectification lead to a description of knowledge as the distinction between the potential and the actual. The potential refers to a system of social-historical-cultural entities, or as Evald Ilyenkov (2012) put it, a "complete totality of possible interpretations—those already known, and those yet to be invented" (Radford, 2015, p.17). However, Radford stated that to get to the actuality, one must set this knowledge as potential in motion to acquire cultural determinations. In general terms, knowledge moves through activity from an indeterminate form of possibilities (potential) to a determinate singularized form filled with content or concrete determinations (actual). Bringing the potential and actual together, knowledge is an archetype of actions, interpretations, reflections, etc.—a system of formal configurations (Radford, 2015). He stated that;

> this form of knowledge results from and is produced through; human social labor, cultural dialectic sensuous synthesis of people's doings, and a dynamic and evolving implicit or explicit culturally codified way of doing, thinking, and relating to others and the world (Radford, 2015, p.16).

Given this, in the fourth stage, teachers implement this designed curriculum in phase three as an enacted curriculum for students to interact through dialogue (Freire, 1972).

> "For Freire, dialogue is a horizontal relationship between people. It comprises communication between Subjects in a critical search or quest for something. Freire defines dialogue as the encounter between men [sic - Freire later repudiated sexist language], mediated by the world, in order to name the world and to transform the world (Freire, 1972). It is a process underpinned by values of mutual respect, humility, trust, faith, hope, love, and critical thinking (Freire,1972; 1998)" (Rule, 2011, p.7).

During the implementation, audio and video recordings of students-students, teacher-students' interactions and dialogues help researchers identify how they use gestures, drawings, writings, to represent the historico-ecologies, deep mathematical thoughts and the transformative and extensions encapsulated in this artifact for collective use. In the fifth stage, the final stage of the method, teachers focus on space creation in the academy by employing extended case study to study the dynamic life trajectories of the curriculum to mainly describe its extension and transformative praxis through large-scale studies. They use these studies to establish the re-sourceability of these artifacts from diverse students to the academy.

Conclusion

In this conceptual proposal, I provide theoretical orientation and methodological approaches which serve as a lens for the mathematics education community to center the increasingly diverse nature of our classroom as a resource that informs curricula planning, design, and enactment, which holds transformative possibilities of extending the field to new frontiers of development.

Although the field is very aware of such approaches, like the renowned funds of knowledge and identity, this emergent Social Design-Based Experiment (SDBE) I conceptualize in this proposal sets out to overcome known challenges with these existing approaches. As seminal work of the funds of knowledge approach points to the lack of a lens to design, which makes the approach fuzzy, SDBE takes a critical stance to develop themes to inform design. Thus, SDBE positions the teacher to plan the encapsulation of the curriculum as a helpful lens to inform the design of the curriculum. These lenses include teachers using findings from literature reviews to identify an educational problem, exploring students' concept conception to identify where they struggle, using surveys to identify students learning ecologies, using political-historical methods to explore the historical development of concepts and the transformative praxis this curriculum brings to the field collectively.

Contrary to the funds of knowledge approach, which is densely teacher-centered, this SDBE conceptualization allows students to participate in the curriculum design. Teachers do this by employing extended case study methods to design. Thus, they provide students with the lens to design I mentioned above, to identify the curriculum from their everyday practices and language use. Hence, the definition of curriculum used in this conceptualization comprises written narratives of students' everyday practices, artifactual designs, language, and cultural practices, which the students identify as encapsulating all the critical lenses to design stated above. Identifying such a curriculum from a homogenous group would be detrimental and challenging to design. Hence, it is out of the need to search for this curriculum encapsulating these critical lenses that I hypothesized the essence of a multicultural and multilingual classroom, thus, diversity as a resource. A heterogeneous group where students come from diverse backgrounds and use different languages provides opportunities for variant artifactual ecologies to design. Another dimension of resource emergent from this diverse group is re-source. Thus, the power of the identified curriculum is to bring the past of the development of mathematical concepts to the present through an imagined future. Although this approach to addressing diversity promises to center it as a resource in three forms, there exists the hypothetical nature of its lenses to design. In addition, planning, designing, and enactment involve longitudinal studies before their impact. Amidst these challenges, although I do not report in this proposal, I have conducted a six-month study in a Ghanaian classroom where I successfully applied the approach. I call on further studies employing this lens to center diversity as a resource in other hegemonic multicultural and multilingual contexts.

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