Chapter 9
Living Authenticity in Science Education Research

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9.1 Introduction

In 1989 Egon Guba and Yvonne Lincoln established a set of criteria on which to judge the authenticity and ethics of qualitative research, the Authenticity Criteria (AC). These criteria were developed in response to the positivistic assumptions of internal and external validity, reliability, and generalizability that guide quantitative research and often extend to the judgement of qualitative research. The AC are responsive to research paradigms that recognize subjectivity and the context-dependent structures that mediate research outcomes. Such research requires a hermeneutic/dialogic approach that places the researcher in the context and requires her to be aware and reflective of how stakeholders experience and interpret their lived experiences in relation to the research context. With this chapter, we intend to underscore the necessity of paying careful attention to the AC, in order to increase the possibilities that all stakeholders can learn, grow, and benefit from engaging in the research process.

We are science education researchers grounded in cultural studies, and we adopt dialogic, participatory approaches in an effort to try to centralize participant perspectives. As such, the AC are critical to our work. The sections that follow elaborate how paying attention to catalytic, educative, ontological and tactical authenticity (Guba and Lincoln 1989) in the research process can facilitate transformations in educational contexts, including classrooms and institutions. The process of research reflexivity extends to the teaching and learning process, as researchers become

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mindful that all participants ought to benefit from the research, as well as from everyday science teaching and learning, both in formal as well as informal settings.

This chapter emerges from conversations at a scholarly writing workshop at the University of Luxembourg, in which we sought to define a research agenda to foster innovation and invite collaboration in science education research. Forty participants from 12 different countries came together for a multi-day workshop, in which participants interacted in small groups on particular foci relevant to the cultural studies of science education. We (authors Christina and Jennifer) were in a group charged with examining issues of equity and social justice in science education research by using our respective research lenses and understandings. Prior to our meeting, we each wrote short reflections on our current research interests and shared them with each other. This enabled us to begin the time together in our workshop by discussing the individual reflections and identifying cross-cutting themes and challenges to doing ethical, equity-oriented research. Our enthusiastic conversations used words that evoked a dialogic, passionate, stakeholder-focused, social justice-oriented research approaches. Yet, when we later created a collective Wordle of our individual five-page descriptions of research, we were surprised to find that it presented quite a different picture. This picture was one of traditional education research, with words such as "knowledge," "schools," and "issues," being the most prominent words that had emerged from our writings. Given that Wordles are created based on word frequency, we were surprised by the resulting image, which stood in contradiction to how we envisioned our own work. This discrepancy led us then to question why our research, as written on paper, was so different from how we presented our research in conversation? This prompted us to revisit Guba and Lincoln's (1989) AC, which we claim grounds the equity-focused work we do, and then ask a larger, more critical, question of our work: Are we living the Authenticity Criteria in how we practice science education research? This question is all the more important if we are thinking about how descriptions of equity and corresponding equitable practices need to be reconsidered, and how we can work to meet the needs of diverse learners, which was one of the key questions we aimed to address in the workshop. Furthermore, we are in a paradigm that seems to place greater value on research that has an experimental design rather than on the kinds of naturalistic work that we do. As such we felt that it was even more important to ensure that our research was aligned with criteria that allows us to measure the "truthfulness" and the impact of our research, and show us where we need to work harder with this alignment. Furthermore, we wanted to ensure that our research is ethically sound and includes both consent and beneficence of all stakeholders involved.

Emerging from our reflexive analysis of this contradiction, in this chapter we draw on our experiences to reflect on what the AC provides for science education research. Further, we consider how the AC is one component of authentic inquiry and discuss the ways that we have extended these criteria towards more ethical practices in our research and research relationships. We use the following guiding questions to frame our dialogue:

- Starting with the AC, what does it mean to do "stakeholder-focused" research?
- What is missing from the AC that may deepen our engagement in research and strengthen the work that we do?
- How can we apply the AC to the communication/dissemination of our work, in order to highlight the necessity of working towards research that centers and benefits participants?

As we address these questions, our theoretical elaborations weave text written in the genre of metalogue throughout the chapter. Metalogue was developed by Gregory Bateson as a type of dialogic text to allow respondents to explore individual and collective epistemologies about a topic (Maran et al. 2011; Roth et al. 1998). Herein, we use this genre to highlight our individual research foci, while engaging in a written dialogue to further our theoretical and methodological understandings on the notion of ethical practices in science education research. We do so with a particular lens on how the AC can serve as a path towards critically grounded, ethical work with participants. The AC, which we elaborate more in the following section, mediate the ethical dimensions of the research that we each do, as they facilitate research focused on the stakeholders themselves, as we highlight from exemplars in our own research throughout the chapter.

Our use of the term "stakeholders" highlights that we aim to empower research participants through the research process. This is in contrast to positivistic research approaches that extract data from the context with the assumption of the neutral stance of the researcher and generalizability of research. With stakeholder-focused research we recognize that research is contextual, and that students, teachers, parents and administrators all can benefit (or be harmed) by the research process. It is our role as researchers to ensure that benefits are realized, harm is minimized, and that, in turn, research contexts move towards more equitable practices. The AC criteria can serve as a heuristic that affords this stance, as we elaborate in the sections that follow.

9.2 The Authenticity Criteria: Our Roadmap for Stakeholder Centered Research

The AC were developed by Guba and Lincoln in response to the positivistic assumptions of internal and external validity, reliability, and generalizability that guide quantitative research and which were often extended to the judgment of qualitative, narrative research. Lincoln (1995) describe authenticity criteria as,

> highly reflective of the commitment of inquiry to fairness (balance of stakeholder views), to the learning of respondents as much as to the learning of the researcher, to the open and democratic sharing of knowledge rather than the concentration of inquiry knowledge in the hands of a privileged elite, and to the fostering, stimulation, and enabling of social action. (p. 277)

The AC were conceived as a heuristic for researchers to engage in stakeholder-centred research in naturalistic settings. These criteria are responsive to research paradigms that recognize human subjectivity and context-dependent structures that mediate research outcomes. The following are brief definitions of the key tenets of the AC (Guba and Lincoln 1989):

(a) **Fairness**, the extent to which the understandings of all stakeholders are accounted for in the research. This is determined by an assessment of the extent to which all competing constructions have been accessed, exposed, and taken into account in the research process, that is, in the negotiated emergent construction.
(b) **Ontological** authenticity, the extent to which the knowledge of individual stakeholders is informed and changed as a result of participating in the research. This is determined by an assessment of the extent to which individual constructions (including those of the evaluator) have become more informed and sophisticated.
(c) **Educative** authenticity, the extent to which individual stakeholders gain an understanding of the perspectives of others. This is determined by an assessment of the extent to which individuals (including the evaluator) have become more understanding (even if not more tolerant) of the constructions of others.
(d) **Catalytic** authenticity, the extent to which the research facilitates changes in the behavior of the stakeholders; stakeholders are empowered towards agency and transformation in relation to the research. This is determined by an assessment of the extent to which action (clarifying the focus at issue, moving to eliminate or ameliorate problems, sharpening values) is stimulated and facilitated by the evaluation.
(e) **Tactical authenticity,** the extent to which stakeholders are empowered to take action that the research implies or proposes. This is determined by the actual actions that stakeholders take towards change.

Jenn: My research focuses on equity in science teaching and learning through studying identity, relationships to places/contexts, informal science education and creativity. My current project is learning about teacher identities in relation to informal science learning. As a researcher, the AC offered me a framework to think about my research beyond just learning about teacher identities in relation to informal science education, but also to view how teachers transform meanings of informal science education to match their identities, goals and teaching contexts. Furthermore, it has been critical for me to extend the AC to encompass authentic inquiry, which Konstantinos Alexakos (2015) describes as research that is holistic, recursive and emphasizes multiple viewpoints and voices, and resists the theory/practice and research/findings dualisms. This has allowed my research to be responsive to changes that happens as stakeholders learn and expand their individual and collective agency as a result of participating in the research. For example, the cultural construct of race in general and Blackness in particular became important in understanding both how their teaching identities emerged during their first years of teaching and how informal science was rede-

fined and enacted both for the collective and vis-a-vis the unique contexts of their individual schools.

Chris: Being responsive to changes that happen in your research is an important contribution that the AC bring to your work Jenn, and the AC can provide a support for better understanding the subjective experiences of the participants. In my own work, my research team and I examine classroom interactions to learn about how children explore, interpret, and discuss their world. In doing so, we are learning much about children's imaginative, creative, and complex notions of science phenomena. This stands in contrast with notions of science as a primarily fact-based subject, a perspective often represented in curricula as well as being common in teaching practices at the primary level. The contrast between teaching practices that reproduce a factual perspective of science, with a focus on answers, and children's engagement in science as a way of investigating their world, with a focus on questions, is used to problematize a discrepancy between how science is taught and how it is engaged in by children. This discrepancy is particularly troubling in the multilingual classrooms of Luxembourg, a country with an immigrant population of approximately 50% (MENJE 2014), and over 150 different nationalities represented. Over the past 25 years, our country has experienced "the highest sustained inflow of immigrants with respect to the total population" in Europe (Eurydice 2004). As this diversity is also represented in schools, many classrooms have children that speak a multitude of languages, but not often the languages of instruction. In unpacking this discrepancy, my research team and I seek to examine how equitable practices might need to be reconsidered to meet the need of diverse (young) learners, and the AC provide a structure for considering this.

The AC recognizes that "education research with human subjects must benefit those who are involved in the study and that researchers have a responsibility to those who agree to be involved that benefits will not be realized only in the future, but will also lead to improvements as the research is enacted" (Tobin 2015). While these criteria are not meant to be formulaic, they provide a heuristic for researchers who endeavour to do stakeholder-centered and justice-oriented research. In such research contexts, the learning is ongoing and benefits are realized at multiple levels by multiple stakeholders. These criteria also foster research approaches that are collaborative and actively engage stakeholders in the knowledge production process so that they are empowered by participating in the research.

Jenn: Similar to you Chris, the AC is a structure for centering equity in my work. I received a National Science Foundation grant to do the teacher identity research. Because I had to articulate a "hypothesis" and narrow framework of how I was defining identity, I went into the project with limited view of the role of how classrooms, schools and students shape teacher identity. I was focused on the practices that they learned in informal settings and how it would be enacted in the classroom. However, because my research approach used methodologies that emphasize stakeholder agency (i.e cogenerative dialogues) the AC came more to

the forefront of how I conducted the research. With this, the view of myself, my research team and my teacher participants were expanded to examine both the nuances of identity and how equitable practices emerged for my teachers because of an increased reflexive examination of who they are as social beings in relation to their students. In addition, I emphasize critical frameworks that highlight the power relationships that structure social life. This, combined with dialogue and AC allowed all of us, researchers and teachers, to become more aware of institutional structures that were barriers to equitable science learning and sought ways, both individually and collectively, to resist, challenge and transform those structures.

Chris: Combining critical theory with authentic research approaches as you mention is a salient way to advance equity in our work. Using analyses grounded in hermeneutics and critical theoretical perspectives, the research that my team and I conduct seeks to reveal approaches to working together with teachers and children towards finding openings, in which the spaces created by the apparent conflict between teachers' expectations and children's realities actually becomes a space of productivity and possible transformation. We work to create structures for teachers to come together reflexively, as they discuss their own science teaching and their students' interactions around science learning opportunities. Prolonged engagement of the researchers and a continual process of participatory engagement of the teachers (through shared data analysis, for example), are central to ensuring that the AC are being met throughout our research process. Teachers are integral to this, as they are encouraged to participate in planning the direction that the research takes, and their perspectives and ideas are central to how our research unfolds over time.

9.3 Critically Grounded Authentic Educational Research: Understanding Why

Our work is guided by critical theoretical perspectives that have been forwarded by Joe Kincheloe, Shirley Steinberg and Paulo Freire amongst others, and grounded in cultural studies approaches as emphasized by William Sewell and Kenneth Tobin. As such, we work to recognize and learn from the contextual complexities of doing research in science education, and we draw on methodologies that can support working with participants in research projects that seek to facilitate transformation. Research can be positioned as the production of knowledge; in science education this is the production of knowledge around science teaching, learning and engagement as well as questioning the foundations of science as taught in schools and out-of-school institutions. Towards that end, Jürgen Habermas (2015) proposed three knowledge-producing purposes, analytical, hermeneutic and critical, each with a different central foci and outcomes. Paul Terry (1997) has linked these purposes to the types of questions that can be approached in research, including:

- An analytic interest in knowledge production supports empirical outcomes ("knowing that")
- A hermeneutic interest in knowledge production supports understanding ("knowing how") and
- A critical interest in knowledge production supports emancipation ("knowing why").

Further, he suggests that these three types of knowledge production purposes can provide a key to understanding education structures (Terry 1997). We believe that it is not enough to know that something has happened, or even to know how it happened. To conduct research grounded through critical perspectives requires us to work towards understanding why it has happened. Only once we understand the why, can we work systematically towards changing practices to be more socially just. We thus conceive that such points on the outcomes (knowing -that, -how, and -why) can also serve as guide for considering the purposes of educational research. With an eye on considering the purposes of research projects with participants, we ask ourselves what is the goal of doing research and what interests are being supported through particular lenses and approaches? With our work situated through critical perspectives we seek to work towards "the question of transcending the existent" (Young 1992, p. 31), which means that we work to unpack meanings and evidences of learning that are taken for granted in order to allow for an expanded view of what is valued as knowing and knowledge production. This is even more critical in science education where science is often positioned as objective, with often deeply embedded cultural notions about who can legitimately participate in the scientific endeavor.

Chris: Recently I came across an article that underscored, for me, the core of what it means to work towards authentic research praxis, as the authors wrote that "Authenticity involves an assessment of the meaningfulness and usefulness of interactive inquiry processes and social change that results from these processes" (Shannon and Hambacher 2014, p. 1). It is precisely the assessment of the meaningfulness as well as the social change that is for me the goal of utilizing the AC to reflect upon the research process. I believe that research should support change and transformation, and it is a goal that I hold dear, as I work to create spaces for teachers to "see" the immense capacities young children have for engaging in science. Young children ask questions about many things that adults may take for granted (Opdal 2001), and as such, my research has sought to highlight children's "wonderings" (e.g., Siry 2013) to both illustrate the diversity and complexity of children's questions, and also to deconstruct the questions together with teachers and teacher education students in order to support recognizing the value of young children's questions and ideas. When we layer onto these different ways of engaging with science the complexities of multilingual classrooms, there is often a tension that emerges between teachers' expectations for science teaching and learning, and children's engagement in science. This contradiction is one that I have increasingly noticed as I work in classrooms, and the AC (Guba and Lincoln 1989) have provided a foundation to examine how to work within,

across, and around these tensions so that the spaces between the teachers and the students becomes productive, and ideally transformative.

Jenn: Meaningfulness, usefulness and social change are important goals to have for conducting research. In my research both with secondary teachers and science faculty, stakeholder-focused research means that while I am learning from and about their identities as teachers or practices as faculty, I am also creating the context that allows them to learn more about their own teaching and desires for transformative learning experiences for their students (cf. Adams 2007). In both instances, I do research and facilitate professional learning. While I learn about them I am also creating a space for them to learn more about themselves and their professional development needs by connecting them with resources to grow and expand their practices towards creativity and equity.

Chris, you also mentioned recognizing and working within the contradictions, this is critical in equity work. In my current work with faculty there is the tension between creativity and assessment. The former tending towards expansive practices and engagement in science learning while the latter towards the rote memorization of discrete facts. The latter is what is expected of students as they advance to upper-level courses – the emphasis on knowing existing scientific knowledge rather than engagement in scientific knowledge production. So, as a faculty community of practice we have ongoing discussions on how to work these tensions while advancing an agenda of creativity. Stakeholder-focused research allows me to center the voices and lived experiences of the faculty and the unfolding learning that occurs in the community; experiencing research as a lived event rather than as a fixed project with a definitive start and end.

9.4 From Authenticity Criteria to Authentic Inquiry: Collaborating with Participants

Our interest in applying the AC in our research stems from participating in Kenneth Tobin's research squad at the Graduate Center, CUNY. There we learned not only how to ask the critical questions of "what is happening" and "why is it happening" as a means of eliciting thick descriptions (Geertz 2008) of our research contexts, but also as a way of engaging stakeholders as a praxis of including their voices in these descriptions. For example, many of us use cogenerative dialogues, "a form of structured discourse in which [stakeholders] engage in a collaborative effort to help identify and implement positive changes in [a given teaching and learning context]" (Martin 2006, p. 694) as a research methodology and praxis to afford stakeholder agency and transformation around the research topic. We have engaged in co-writing and co-researching with participants, and in doing so have explored the necessity of seeking different perspectives in the research process (e.g., Siry and Zawatski 2011), the value of co-teaching for professional development (e.g., Siry and Lara 2012) and ethical implications of collaborative research (Siry et al. 2011). With equity and social justice as central to our work, it is important to create and

learn from contexts that allowed stakeholder to engage in meaningful and relevant science learning experiences. Furthermore, we value critical approaches that recognize the political nature of knowledge and knowledge production along with the power dynamics that exists in institutional structures that often serve to maintain societal status quo, for example structures that contribute to urban schools having inadequate resources for rich and expanded science learning. Using the AC as a heuristic for engaging in critical, social justice-oriented research affords opportunities for all stakeholders to participate in learning about and improving science teaching and learning.

Jenn: When I and my colleague Preeti Gupta enacted research on youth identity in relation to working in a science center as Explainers, (see Adams and Gupta 2013), we emphasized the learning aspect of the project. It was both about learning about youth science-related identity and the young people learning both from each other and the researchers about being better informal science educators. Keeping stakeholders' voices central to the research allows us to both gain a deeper understanding of various sociocultural issues in relation to science teaching and learning as well as affording participants agency in transforming these contexts to be more meaningful, relevant and socially just. In my research about science teacher identity, race became a very important social construct that shaped teacher identity and enactment and the teachers worked both individually and collectively to create learning contexts that afforded success in science for their Afro-Diasporic and Latinx students of color (who in the United States remain underrepresented and underperforming in science). Centering diverse voices and perspectives provides a deeper understanding of contexts for teaching and learning and how different people participate in learning. The AC lends itself to research approaches that are collaborative and multi-perspectival. The AC supports authentic inquiry that centers the well-being of all stakeholders in research. Central to authentic inquiry is agency and transformation; it is expected that the research contexts and stakeholders should change from participating in the research; if the research is done correctly all stakeholders should gain a deeper understanding of the educational context and issues at hand and collectively work towards improving teaching and learning for all. Tobin (2015) notes, "authentic inquiry addresses additional values concerning ethics and acknowledges that all knowledge is inherently political, reflecting participants' in social space" (p.12).

Chris: Those examples illustrate how the AC can afford guiding constructs for conducting research that is fair, transformative, and equitable. As researchers in two diverse international contexts, careful attention to the AC allows us to make science education research a more participatory process and increase the possibilities that all stakeholders will learn, grow and benefit from engaging in the research process. By focusing on ontological, educative, catalytic, and tactical authenticity in the research process, classrooms, contexts and institutions have the potential for transformation. This process of research reflexivity extends to the teaching and learning process, as researchers become mindful that all participants are benefitting from not only research, but from everyday science teaching and learning, both in formal and informal settings.

Keeping the AC central to our work allows us to be reflexive researchers who aim to continuously reflect on our commitment to improving science teaching and learning. With this reflexivity we strive towards fairness, in that we seek to facilitate research in which all participants' voices are heard and considered. As we move through the research process with our participants, we intend to continually and recursively assess the authenticity of the work we are doing. For us it is important to consider participants' awareness of the complexities of their social environments (ontological authenticity) as well as the extent to which they express increased awareness and respect for the perspectives of others (educative authenticity). These can be facilitated through methodologies that work towards dialogic encounters amongst all stakeholders (Shannon and Hambacher 2014). Catalytic and tactical authenticity both require focusing on change as there ought to be empowerment that results from the research, however, this can be difficult to assess as it is not always easy to "see" such changes. Catalytic authenticity is evident if there was action stimulated by the stakeholders, and tactical authenticity implies a redistribution of power (Shannon and Hambacher 2014). The reflexive space that the AC affords allows us to create dialogic structures that welcome participant voice, and that mediate participants' agency and the potential for action on the part of stakeholders.

Chris: As a science education researcher and educator the AC provide me a lens to ensure that the research I engage in with young children and their teachers is as fair and equitable as possible. With the methodologies I have adopted in my work, I seek to be as participatory as possible, and I strive to work towards gaining a multiplicity of perspectives on science education in the primary school classes that my team and I conduct research with. Strategies that we implement to support the AC include positioning participants as central to the research and working together to collect a diversity of data resources that serve as points for individual and collective reflection and discussion. Keeping an eye on the AC throughout the research process underscores the necessity of providing participants a voice, and most importantly, considering and reacting to participants input. In doing so, we work together to create structures that mediate teachers' and children's agency in the teaching and learning of science.

Jenn: Similarly, the AC provide me with a heuristic to ensure the rigor of my research and allow for a framework that emphasizes collective learning and stakeholder agency. With my research team we emphasize dialogues in our data collection methods. We had two groups, teachers who participated in 45-min interviews about their practice and a longitudinal group of (then) new teachers with the goal of learning how their teaching identities and corresponding practices unfolded during their first years in the classroom. For the first group, we developed interview questions that prompted an exchange between the researcher and teacher participants rather than a didactic question and answer approach. This allowed for a natural conversation about teaching to unfold and both the researcher to exchange ideas and examples about science teaching and learning. In the ongoing group we used a cogenerative dialogue approach (Martin 2006, see above) and this allowed for authentic voice and creating a community of

learners rather than the strict dichotomy of researcher and researched. As the lead researcher and with the AC in mind, I have an ongoing concern of the learning of stakeholders – that they are learning from participating in the research as myself and my research team are learning about the focus of the research. In the teacher research, this means that they are continually learning to teach, in the case of this research, learning how to adapt and use available resources to meet their teaching and learning goals. Also affording them the space to develop their own meanings about what it means to teach science in a diverse, urban context.

9.5 Relationality, Trust and Well-Being as Emerging Authenticity Criteria

Earlier we posed the question of "what is missing from the AC may deepen our engagement in research and strengthen the work that we do?". This question allowed us to first consider that the AC is in many ways a living document. It was created nearly three decades ago and while it is both seminal and relevant, as we continue to transform research to be more authentic to and in teaching and learning spaces, these criteria will also evolve. In other words, if we conduct research that is true to the AC, it is expected that both research and subsequently the AC will change in order to both mirror and validate new research/educational contexts. Here we reflect on or research and discuss related emergent criteria.

Jenn: Chris, we talked about trust and relationality and how it is important to first build trust between the researcher(s) and research participants and amongst research participants. Trust is described as, "people's willingness to be vulnerable due to their confidence that the individual(s) they interact with are open, benevolent, reliable and honest" (Id-Deen and Woodson 2016, p. 45). Trust is developed through positive interactions and ownership with the foundations of trust based on shared expectations, persistence, commitment, and voice (Ennis and McCauley 2002). Extending this to research, we could see where a criterion of trust (beyond trustworthiness) would be important in creating and maintaining a research context that authentically affords the equal participation of all stakeholders. This would attenuate the power dynamics that often exists between the researcher and researched and teacher and students if all are working towards a sense of safety and mutual respect for all stakeholders.

Relationality also resonates with my research. With relationality described as, "relational dynamics shape processes of partnering and the possible forms of learning that emerge in and through them" (Bang and Vossoughi 2016, p. 174), I can see where relationality, combined with trust has enabled much more expanded learning both for the research participants and for my research team. For example, creating a space of mutual trust has allowed the teachers to develop a sense of agency in how they define and enact informal science learning in their classrooms. I enacted what Rita Kohli (2014) refers to as "reciprocal vulnerability" where I shared my own experiences with learning to teach science in the same

urban contexts, including my successes and failures, in order to create a space where the teachers felt safe and comfortable in sharing their own. Listening to their experiences allowed me to expand my definition of informal science learning and think more deeply about teaching enactment, in terms of the transformation of resources at hand to envision new learning opportunities for students, and its relationship to identity. This has also been important in my work around creativity – creating a safe and trusting space to allow faculty to discuss their practices, feel agency in how they are conceptualizing creativity and begin to push the boundaries of their thinking about what is possible in the classroom. I do this within a community of practice framework and with the AC in mind I establish it as a cogenerative space where, as the facilitator/researcher, I emphasize shared meanings and encourage risk-taking through trying and sharing new pedagogical enactments in their classrooms and labs.

Chris: I am in complete agreement with you Jenn, as I believe that trust and relationality are the cornerstones of ethical research. Neither of these are ensured by the AC however, and we should take a moment to reflect on this. The AC emerged from a time in education research that was predominantly guided by positivistic paradigms, and there was a need to develop criteria to "match" criteria from such positivist paradigms, such as validity and reliability. As such the AC help us work towards research that is authentic and hopefully transformative. What is missing however is an explicit focus on the well-being of the participants in that they feel they are in a safe environment to express their ideas and have them be heard as well as respected. Trust and positive relations are at the heart of ensuring well-being, and thus I personally feel that while the AC help us get there, we have to always be vigilant that we are taking care of those who are research participants.

Jenn: Chris, you articulated it well with "explicit focus on well-being," this critical not only for our research participants but also for our research teams. As leaders of research teams, we have to create spaces of trust and safety that allow our teams to also grow and expand as researchers. I believe that we have learned as much as we have about equity in our respective projects because we value and center perspectives our both our co-researchers and research students. The different lenses that they bring to our research process allow for us to develop expanded views of constructs like identity, agency, language interactions and learning. The AC have been a guiding heuristic but trust and relationality have extended the scope of work and lens of equity that we collectively apply to our research.

9.6 Extending the AC to Dissemination Research Practices: Highlighting the Value

Central to the AC is the learning and agency of all stakeholders. This does not end with the actual research but continues with communication and dissemination practices. This means that not only should others outside of the immediate stakeholders

benefit from the research but also that all people have equitable access to the products of dissemination.

Jenn: This is an ongoing issue for me because so much of what we do in the academy is counted by the number of publications in "high impact" journals. However, if we think of our stakeholders, in my case classroom teachers, how will they access this research? It is not that teachers do not read educational research, but unless they are in graduate school, their reading is relegated to practical applications to the classroom; knowledge that will help them to be more effective at teaching. Furthermore, for science teachers, it is becoming increasingly important for them to keep up with advances in the subject area. Based on my experience of being a science teacher and later a science teacher educator both in a museum and in a university setting, I have learned that teachers learn by doing and through dialogues with other educators. Teachers learn to teach when they have opportunities to engage in the same activities that they are expected to do with students while thinking about adaptations to their unique learning contexts (i.e. Adams and Branco 2016). The teachers in my research have been learning from other research participants and from sharing their work at local and national teacher education conferences. These are key points of dissemination where teachers are able to share their understandings and enactments of informal science education with other teachers towards wider equity in science teaching. The educative tenet of the AC emphasizes the importance of educating others, beyond the immediate research participants, of what is learned in the research. So, I think we need to think about the key stakeholder audiences and their common channels of communicating and accessing those in order to reach broader members of given stakeholder audiences. For teachers this means engaging in professional development and targeting practitioner-oriented media.

Chris: The implications from my research point to the complexities of the way science is framed as a content area in school curricula and the ways in which science is 'done' by children in the primary school years (e.g., Siry and Lara 2012; Siry 2018). A contribution from this work is to underscore the need for supporting teachers and teacher education students in rethinking science education as a discipline in order to provide more equitable, authentic, practices for reaching diverse learners. However, as mentioned, the publications that typically "count" in the academy tend not to be the ones that practitioners might be reading. The AC compel us to find other venues for disseminating our work so that there is an educative component beyond the research-oriented publications. As such, it is important to find spaces that value teachers' and students' perspectives; presentations, publications, exhibits, demonstrations, etc. and encourage the research participants to actively engage in collaborative disseminations. I have written previously about the value of co-writing with students and research participants (e.g., Siry and Zawatski 2011) and my experiences have underscored the necessity of doing so. As we put thoughts to word and then to paper together, we share a creation of new meaning, and this is a powerful tool towards transformation in my experiences, one that is guided by the AC.

Jenn: It also behooves us, as stakeholders, and due to our status as mentors and leaders; gatekeepers in the academy, to take a critical stance on what counts as research. It is important for us to create opportunities for our students and mentees to disseminate research in ways that are valuable to stakeholders and to allow that to "count" as productivity in the academy. We would not be holding ourselves accountable to the AC if we maintain the status quo of focusing our communications within the academic community.

9.7 Dialogues and Reflections Towards Action: Closing Thoughts

We began this chapter by introducing the AC as a central focus in our research processes, and we have sought to add context and meaning through the use of the genre of metalogue. For us, the AC are a foundation for conducting authentic inquiry (Tobin 2015). Authentic inquiry as a methodology is grounded on the AC and relates to the well-being of all stakeholders in research. Using the AC as a guide, authentic inquiry has agency and transformation as central outcomes for research; as such, it is expected that the research contexts and stakeholders should change from participating in the research. If the research is focused on equity, then diverse stakeholders should gain a deeper understanding of the educational context and issues at hand and collectively work towards improving teaching and learning for all.

Chris: Stakeholder-focused research, as we have described above, requires reflexivity throughout the research process. Jenn, you said that teachers in your research come together to reflexively consider connections between informal science learning opportunities and their own identities, which is one critical component of working together towards equitable practices. In my work, we seek to create dialogic spaces with a goal of working towards a sort of reconceptualization as well, focused on what it means to teach science at the primary school level, and as in your work, this process begins first with creating a space that is open and responsive to participants' voice and reflection.

Jenn: I agree, dialogues and reflection are critical, and creating the spaces that allow for this to happen is paramount. This has been important not only in my research with teachers but also in working with my research team. I believe that this is similar to your team, Chris in that you create a space for your researchers to build their own theoretical lens while contributing to the overall knowledge production of the team. In my teacher identity work, my team engaged in a collaborative diffractive analysis where we avoided identifying themes and patterns that would bind the data but rather engaged in a "constant, continuous process of making and unmaking...arranging, organizing and fitting together" (Jackson and Mazzei 2012, p.1) where we applied different theoretical frameworks to the same data set. So, this open space of equity is central to my way of engaging with my research team.

I also feel that the AC, with its emphasis on stakeholder agency, has become embodied in my way of doing research, so for new projects I always seek to center stakeholders voice and perspective. For example, on a current research project, which focuses on creativity and science teaching and learning in postsecondary settings, the AC has allowed me to create a stakeholder-centered space where science faculty contribute to learning about creativity in science education while enacting it in their teaching spaces. I present existing frameworks that we discuss and they consider how it translates into their practices. This has allowed a community of practice with a shared vision of developing and enacting creative practices in science education to grow.

Our work with teachers, faculty and students has underscored for us the necessity of using the AC as a start towards assessing if we are truly working towards ethical and transformative research. But much as with the Wordle we generated in 2014, speaking and writing about these issues is not enough, as otherwise the picture that is represented of the research process is one that can reproduce positivist paradigms. Rather, the AC should serve as a continual reminder to ensure that the research process benefits all stakeholders and that research is authentic to the multitude of experiences of participants and that it mediates change as well as transformation towards more equitable science education practices.

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