Capabilities-Development-Within-Nature Pedagogy: Science Education Through and For Well-Being

Michael Link

University of Winnipeg, Winnipeg, Manitoba

Thomas Falkenberg

University of Manitoba, Winnipeg, Manitoba

Abstract

This chapter introduces and elaborates on the idea of preparing teacher candidates for purpose-focused instructional design thinking in science education through purpose-focused science teacher education. A particular purpose of school education will be privileged: education for well-being. The chapter elaborates on this specific purpose and then proposes a particular approach to design thinking for the teaching of science that builds upon the identified school-educational purpose. Finally, the chapter suggests that such purpose-focused instructional design thinking can be the foundation for science teacher education that contributes to school education for well-being, and how this can be achieved.

Résumé

Dans le cadre de la formation conceptuelle des futurs enseignants, ce chapitre présente et développe la notion d'une adaptation de l'enseignement des sciences. Il a pour but principal l'enseignement du bien-être qui se trouve au coeur des objectifs privilégiés de l'enseignement scolaire. Le chapitre conclue, tout en en exposant les modalités d'application, qu'une telle conception pédagogique de l'enseignement des sciences, alliée à l'objectif éducatif scolaire

poursuivi, peut servir de base à la formation des professeurs de sciences qui contribuent à l'enseignement scolaire du bien-être.

While there are many ways to define design thinking, its central idea can generally be described (Cross, 2011; Razzouk & Shute, 2012) as a cyclical problem-solving process that involves:

- trying to understand the situation or people involved;
- addressing critically the assumptions behind the problem and even the problem itself;
- creating prototypes to address the problem; and then,
- testing and evaluating those prototypes.

Design thinking has its roots in engineering and architecture (Lawson, 1980). More recently, design thinking has branched out into a number of other fields, most notably in business and education (Brown & Kātz, 2009; Laurillard, 2012).

In the field of education, design thinking has been conceptualized as a tool for providing students opportunities to address real-world problems. More to the focus of this chapter, design thinking has also been used within the field of teacher education to broaden the role of teachers from classroom *practitioners* to that of *curriculum designers* (Henriksen et al., 2020). There are a number of models of design thinking related to educating teachers as curriculum designers, such as the Stanford Design Thinking Model (Roman, 2018, pp. 140–141).

While one of the primary traditional focuses of teacher education programs has been on teaching practice and its connection to theory (Carlgren, 1999), it has been argued that teacher education programs have typically not emphasized the role of teachers as designers of curriculum. Rather than advocating for a specific design thinking process, this section provides a concrete example of teachers as curriculum designers within a unique pedagogical approach called the Capabilities-Development-with-Nature Approach, which we describe below. This chapter explores the idea of preparing teacher candidates as curriculum designers in science education for well-being through this particular educative approach. The Capabilities-

Development-with-Nature Approach seeks to address the foundational needs of students through the development and enactment of capabilities designed by teachers with parents' collaboration. The process of designing opportunities for the development and enactment of needs-linked capabilities is elaborated upon in the following pages. This teacher-designed approach provides a tangible example of teachers as curriculum designers, which may be of interest to both teacher educators and teaching practitioners interested in the development of a science-based education for well-being approach.

An Education for Well-Being

A number of researchers have suggested making the concern for humans to live a flourishing life (a life of well-being) the primary focus for school education (e.g., Brighouse, 2006; White, 2011). Some approaches to human well-being consider the availability of capabilities to address human needs a core aspect of what it means to live a flourishing life (e.g., Falkenberg, 2019; Nussbaum, 2011). Bringing both scholarships together, we arrive at the position that a primary focus of school education is to develop in students those capabilities required for them to live a flourishing life. In this section, we draw on this literature in order to make the case for an education for well-being.

Brighouse contends that as adults, our role in the care of children involves making certain choices with regards to what an education for well-being looks like, just as we would make certain choices regarding what a healthy meal for a child looks like. Consequently, it falls upon the adults who care for children to decide what makes a life lived well and how we might educate for one (Brighouse, 2006, p. 42).

First of all, there are both present and future interests concerning child well-being. With regard to the need to participate in social life, children presently require the capability to make and maintain friendships in order to flourish (present interests). In the long-term, this capability

is equally important and may also be categorized as a future interest. The capability to participate in civic life, through various perspectives that reflect personal values, is an example of a capability linked to the need to participate in social life that leans further towards a future interest categorization. Although, in the present engagement of children and youth in demanding greater attention to the climate crisis, this too may be seen as a present interest in which an education for well-being might need to give consideration.

In addition to present and future interests, Brighouse argues that there are fundamental universal interests towards a flourishing life, for example, the interest in being capable of securing food and shelter or making choices with regards to religion (p. 44). However, children also have particular interests that are unique to them, such as the development of certain types of music or sports. The challenge for teachers and parents is in determining those "fine-grained judgements," as Brighouse calls them. Administrators and policy-makers concern themselves with broader decisions directed at the general interests of students, "and how to set up an institutional framework within which those general interests are well served, and in which teachers … can make and implement good fine-grained judgements about particular interests" (Brighouse, 2006, pp. 44–45). Brighouse identifies autonomy as a general and universal interest that is an important aspect of a flourishing life, one that should be taught in schools (Brighouse, 2006, chap. 3). As elaborated below, the development of autonomy based on students' rights to agency plays a key role in the successful development and implementation of the Capabilities-Development-with-Nature Approach.

The question for the teacher as curriculum designer then becomes what experiences should be made available to students. White (2011) argues that the primary purpose of schools should be to equip "everyone with the wherewithal for a flourishing personal and civic life" (p. 144). White asserts that schools should continue to teach knowledge, but in ways that are more integrated and

meaningful to students. How might we come to decide or agree upon what a flourishing personal and civic life looks like? Brighouse (2006) suggests learning about parenting, dealing with stress in the workplace, recognizing and responding to the pressure of over-consumption, and making good use of leisure time, among other suggestions along these lines (pp. 54–55). While the traditional curriculum has served as an obstacle to the development of well-being and has benefited those with privilege, White (2011) argues for an inclusive approach to an education for well-being, one that is in the service of all. If those who have not had a voice in schools should be served in the pursuit of well-being, who then decides what the focus will be? White (2011) contends that schools—including teachers, students, and parents—should have the freedom to decide upon the goals of a schooling for well-being approach. The participatory involvement of the school community plays also a key role in the Capabilities-Development-with-Nature Approach (see below).

As a liberal moral philosopher, Nussbaum (2011) is interested in what opportunities or freedoms are equitably available to individuals in order for them to live the life that they consider worth living. However, as the Capabilities Approach suggests, to actually have such opportunities and freedoms, people need to develop and be able to enact agentic capabilities. While Nussbaum (2011) states that the decision concerning the capabilities that are valuable need to be communally debated and decided upon (pp. 32–33), she does suggest that there is a "widely shared understanding of the task of government" in securing certain minimum threshold levels of what she calls "Central Capabilities" (p. 33), among which she lists: being able to have good health, being able to engage in critical reflection about the planning of one's life, being able to engage in various forms of social interaction, and being able to participate effectively in political choices that govern one's life.

A central feature of Nussbaum's Capabilities Approach is agency. The individual must have freedom and control over the enactment of their capabilities. While the opportunity to develop (further) and enact capabilities towards well-being is made available, people can decide for themselves whether or not they want to enact that capability in a given situation. Meeting basic human needs that contribute to well-being and allowing for agency over the enactment of the capabilities relevant to a need, may be seen as a matter of social justice or an equitable distribution of opportunities necessary to live a good life. For example, a child may have a natural "ear" for music (an individual characteristic), but no external opportunity to experience or learn a musical instrument due to conditions of poverty (external features). For certain agentic capabilities to develop, opportunities must be available. Schools may be seen as places where opportunities are made available to children to grow and develop. The nature of the school will dictate how narrow or broad (or how explicit or hidden) the opportunities for children to develop capabilities will be.

In order to make decisions concerning what capabilities are worth developing, one might ask "to what end?" Those concerned with human well-being may begin by considering what basic human needs are needed for a flourishing life. Max-Neef (1991) developed a list of nine fundamental human needs: subsistence, protection, affection, understanding, participation, idleness, creation, identity, and freedom. These needs are addressed in the form of "needs satisfiers," which are, as the name suggests, attempts to satisfy needs. The fulfillment of any of the needs contributes to well-being, while a deficiency in any of the needs results in a "poverty" of that aspect of well-being. Also, the interconnectedness of the needs is such that a satisfaction of one need may potentially lead to the impoverishment of another.

Building on Max-Neef's fundamental human needs model and Nussbaum's capabilities approach, Falkenberg (2019) offers a framework for the conceptualization of human well-being

called the Well-Being and Well-Becoming Framework (WB2-Framework). This framework is characterized by a systems perspective that includes people as "bio-psychic systems" and "as social actors of social and ecological systems" (p. 4). The WB2 Framework provides a framework for conceptualizing well-being. This conceptualization necessarily "requires the consideration of the social-cultural context in which an understanding of well-being and well-becoming is needed" (p. 5). The WB2-Framework is an integrated approach to understanding well-being and well-becoming, drawing from many disciplines to arrive at a holistic understanding of what it means to live well. A key feature of the WB2-Framework that the Capabilities-Development-with-Nature Approach is adopting is the notion that human needs must be met in order for humans to live a flourishing life (a life of well-being).

Another core characteristic of the WB2-Framework that is particularly relevant to the idea of an education for well-being is the notion that humans are constantly "becoming" (Falkenberg, 2019, p. 13). Such becoming is the result of the ongoing interaction between a human being and their environment:

> This dynamic systems view of human *beings* suggests that even as we assess our own or someone else's state of being at a given time, there is a dynamic element in that being, namely the potential of the system to develop in certain ways rather than in others and to be attentive to certain ways of system disturbances by the environment rather than to other ways. (p. 13)

The dynamic aspect is "integral to understanding the quality of a person's present state (well-being)" (p. 5). As Falkenberg writes, "*well-becoming* expresses the dynamic aspect of well-being and *well-being* expresses the momentary state of well-becoming" (p. 14).

Nussbaum's Capabilities Approach and Max-Neef's fundamental human needs approach to human well-being, brought together by Falkenberg's WB2-Framework, provides a foundation for The Capabilities-Development-with-Nature Approach to Science Education.

The Capabilities-Development-with-Nature Approach to Science Education

While there have been fluctuations in emphasis, most of the goals of science education have remained fairly consistent over the past several decades (see, for instance, DeBoer, 1991; Donovan & Bransford, 2005; Duschl et al., 2007; Pedaste et al., 2015). Broadly speaking, the teaching of science may be divided into three categories:

- learning of knowledge disseminated by scientists
- learning the ways of scientific thinking
- learning the practices of scientific inquiry

Many students of science have experienced an emphasis on the learning of knowledge, often in the form of reading a textbook and reproducing the knowledge disseminated in it, with little to no emphasis on ways to think scientifically and practices of scientific inquiry. This chapter focuses on an approach to science education that provides students opportunities for scientific inquiry in a way that fosters the development of capabilities required for them to live a flourishing life.

An Illustrative Case Study of the Approach in Action

One of the authors (Link, 2018) studied an approach used in a Manitoba elementary school to teach science for its impact on the development of students' capabilities required for their well-being. Link called this approach to teaching science the Capabilities-Development-with-Nature Approach. This teacher-developed pedagogical approach integrates outdoor education with a Reggio Emilia-inspired philosophy of education. In this approach to science teaching, the

outdoors are utilized to provide opportunities to develop capabilities required to fulfil human needs and positively contribute to well-being.

In the Reggio Emilia approach, children are viewed as curious beings with many questions about the world around them. In response to this view of children, the teacher designs the curriculum based on children's questions but also designs the classroom in such a way as to provide opportunities for child-led research and creative work. The following (see Edwards et al., 2012) describes the central features of the Reggio Emilia approach to teaching and learning:

- The focus of curriculum is informed by the interests of the children.
- Teachers and children communicate and collaborate to answer questions through inquiry and project work. Teachers make curricular decisions based on the children's questions and interests.
- The environment is designed as a third teacher in order to spark the child's curiosity and creative work.
- Teachers document children's learning through creative visuals.
- Teachers recognize the numerous ways that children may express themselves. This is called the "one hundred languages of children."
- Opportunities for inquiry projects and creative work are designed to encourage collaborative, rather than individual, efforts.

A typical Reggio Emilia classroom includes well-organized areas for different types of engagement, including quiet individual engagement, small and large group discussions, inquiry and creative work, and imaginative play (Edwards et al., 2012). As Fraser (2006) describes it, such a classroom—understood as "the third teacher"—also recognizes the child's voice: "A classroom that is functioning successfully as a third teacher will be responsive to the children's interests, provide opportunities for children to make their thinking visible, and then foster further

learning and engagement" (p. 67). The child's voice is represented in the design of the classroom concerning the questions investigated and the opportunities for creative work and play. As Heard and McDonough (2009) observe:

> We need to think about creating classroom environments that give children the opportunity for wonder, mystery, and discovery; an environment that speaks to young children's inherent curiosity and innate yearning for exploration is a classroom where children are passionate about learning and love school. (p. 2)

Following the Reggio Emila philosophy, in the Capabilities-Development-with-Nature Approach the third teacher extends into the natural world. "Wonder, mystery, and discovery" are all readily fostered through immersion in the outdoors. Children's questions and interests are recognized and reflected in the way in which engagement in outdoors is designed. By extension, the experiences in the outdoor environment (third teacher) can also provide provocations for inquiry and creative work and play in the indoor environment.

Using nature as a third teacher, this outdoor education approach sparks the children's curiosity and offers them opportunities to develop and enact the capability of asking questions about the natural world they encounter. In the Reggio Emilia approach to teaching and learning, students are provided with a provocation or something that triggers their curiosity, thereby leading to an inquiry project. Provocations in the Reggio Emilia approach typically happen within the classroom. In the Reggio Emilia-inspired outdoor education approach studied in Link (2018), it is the use of nature that provokes curiosity.

In the Capabilities-Development-with-Nature Approach, students are provided opportunities in nature to develop and enact capabilities that have been identified as necessary to meet fundamental human needs, and to ask and voice questions and ideas about what they encounter. These questions are recorded by the teacher and then may form the basis for a

student-led investigation. The development of this particular capability (asking questions) may also lead to, or overlap with, other capabilities. As children are provided opportunities to ask questions, they are also afforded opportunities to develop the capability to explore and discuss the ideas and questions they have about nature, and also to care, appreciate, and connect with the natural world.

What capabilities are valuable for development? Who decides? The capabilities supporting well-being in schools are selected by parents, teachers, Elders, and others through the lens of a fundamental human needs framework developed by Max-Neef (1991), as discussed above. The school community group participating in the study determined the focus of the evaluation based on the following questions:

1. What needs, as aspects of student well-being, are you interested in investigating?
2. What student capabilities are required to fulfill those needs?

Once both the human needs and corresponding capabilities were identified by the school community group, teachers then began the work of curriculum design. Teachers created experiences to provide students opportunities to develop and enact the identified capabilities. Select capabilities were directly linked to student engagement in scientific inquiry. The following examples illustrate the link between a particular way of engaging in scientific inquiry and the development of well-being capabilities.

A group of grade 1 and 2 students were returning from a walking field trip when two students noticed some bumblebees floating between the dandelions. They stopped, crouched down, and observed this behaviour. The rest of the class, with the teacher's encouragement, followed suit. When the students returned to the classroom, the teacher asked the children to reflect on the experience. She asked them what questions came to mind. Some of the students had ideas that the bees were involved in this behaviour in order to make honey, but they had

many questions involving how this all happened. These questions formed the basis for student-led research into the behaviour of bees. In this example of the pedagogical approach, the teacher provided opportunities for the students to develop and enact the capability to voice questions that they had about what they observed in nature (and the opportunity to observe the bees in the first place) and to explore the questions they had through teacher-supported research.

Table 1 outlines the entire list of needs and capabilities, identified by school community members, that led to the study of the Capabilities-Development-with-Nature Approach, along with some more examples of the development and enactment of those capabilities.

Table 1

Needs, Capabilities, and Examples From the Findings

Need	Capability	Example from the findings
Creation	To make choices about what to create	A representation of a garden gnome village in the forest, built with elements of nature
Understanding	To ask questions about the natural world	Observing and asking questions about forest tent caterpillars on the window ledge of the school
Freedom	To explore student-generated questions and ideas about nature	Exploring questions about water insects (back in the classroom) that were inspired by a trip to the local pond
Affection	To appreciate and care for nature	Appreciating bees and caring for spiders
Identity	To experience a connection to nature	The peaceful heart meditation practice at the forest, pond, and other local sites.
Participation	To voice questions and ideas, and to listen to others' questions and ideas about nature	Voicing and listening to ideas and questions during a cankerworm debate (should the cankerworms here be destroyed to prevent them from destroying this tree?)

Note. This table is taken from Link (2018, pp. 68–69).

A Capabilities-Development-with-Nature Approach to Science Education underlines the meaningful aspect of the practice of engaging in scientific inquiry by providing opportunities for students to explore questions that they have about the natural world.

Theorizing the Capabilities-Development-with-Nature Approach to Science Education

The example of the Capabilities-Development-with-Nature Approach described in the previous section illustrates the following principles of this approach to science education:

Theoretical Principles:

- To have capabilities that allow humans to address their fundamental human needs and to have opportunities to enact those capabilities are core components of what it means for humans to live a flourishing life.
- A core purpose of school education is (a) to develop students' capabilities that allow them to address their fundamental human needs as students and future adults; and (b) to provide students with opportunities to enact such capabilities.
- Human needs and the capabilities needed to address them can only be understood within a socio-cultural context.
- Human needs can be addressed through capabilities that involve our relationship with the natural environment. In light of our general disconnect from the natural environment, and of the consequences that that has on our ability to address fundamental human needs, concern for capabilities involving our relationship with the natural environment in order to address human needs has become imperative.

Science Teaching Design Principles:

- The central purpose of science education is to contribute to the core purpose of school education described above.

- The socio-cultural community (e.g., through parents) ought to be involved in identifying a community-relevant understanding of human needs and of capabilities required to address those needs that science education can and should address.
- Wherever possible, learning experiences for students are planned and provided within and through engagement with the natural environment for the purpose of developing capabilities needed to address identified human needs.

Above we have referenced three broad categories of learning that frame current science pedagogy: learning of knowledge disseminated by scientists; learning the ways of scientific thinking; and learning the practices of scientific inquiry. Drawing on the principles of the Capabilities-with-Nature Approach to Science Education, we can now use the following questions as criteria for assessing the appropriateness of learning opportunities designed to address each of the three categories of science teaching:

- How are the knowledge and the ways in which that knowledge is developed by students contributing to the development of students' capabilities that can inform their ability to address their fundamental human needs in order to live a flourishing life as students and future adults?
- How are the ways of scientific thinking (and the possible neglect of other forms of thinking) and the ways in which those are learned by students contributing to the development of students' capabilities that can inform their ability to address their fundamental human needs in order to live a flourishing life as students and future adults?
- How are the practices of scientific inquiry and the way in which those practices are learned by students contributing to the development of students' capabilities that can

inform their ability to address their fundamental human needs in order to live a flourishing life as students and future adults?

- To what degree are the knowledge development, the learning of scientific thinking, and the learning of scientific practices happening within and through engagement with the natural environment?

In the next three sub-sections, we briefly illustrate some implications that the lens of the Capabilities-with-Nature Approach to Science Education and the WB2- Framework has for purpose-focused design thinking in each of the three categories.

Learning of Knowledge Disseminated by Scientists. The Capabilities-with-Nature Approach to Science Education suggests that the capabilities to be developed in science education are *agentic* capabilities in the sense explicated in the WB2-Framework (seeFalkenberg, 2019, pp. 16–20). This implies, among other things, that the capabilities are grounded in a *range* of forms of knowing. Following Mingers (2006), we can distinguish between propositional knowing and performative knowing (though there are more forms to distinguish). While the former involves being "cognisant of states of affairs" (p. 137), the latter is "to know *how*" (p. 137). When Mingers (2006) points out that to know how "generally involves explicit training in order to develop the necessary skills" (p. 137), he points to the distinction that one can know states of affairs within a life domain without being practically able to actually live "knowledgably" within that life domain, because one misses the "know-how" required for it. In terms of knowledge disseminated by scientists within school education, this distinction between knowing that and knowing how suggests that we can propositionally know what makes for a healthy meal—by studying the propositional knowledge developed in nutritional science—without actually being able to live a culinary and nutritionally healthy life, because the latter requires a complex set of skills, including preparing appropriate meals within certain budgetary

constraints and the availability of certain kinds of food. Thus, for the design thinking in science education, the Capabilities-with-Nature Approach to Science Education suggests to consider *multiple forms of knowing* to expand the contribution science teaching and learning can make to the development of capabilities for students' present and future well-bein.

Learning the Way of Scientific Thinking. One way in which the lens of the Capabilities-with-Nature Approach to Science Education impacts the learning way of scientific thinking is by emphasizing a *moral imperative* for scientific thinking grounded in a sense of responsibility toward the ecological system that is the Earth. Environmental education scholars (e.g., Orr, 1991, chap. 2) and ecological economists (e.g., Schumacher, 1999) have emphasized the moral imperative of living responsibly and sustainably in the natural environment of which humans are an integral part. For the Capabilities-with-Nature Approach, the purpose of science education is to help develop students' capabilities that allow them to address their human needs as students and future adults; however, the approach does so from a perspective of an ethics of sustainable well-being as it has been, for instance, proposed by Falkenberg (2020). Thus, the Capabilities-with-Nature Approach suggests the design thinking in science education must include a moral imperative to direct and frame all scientific thinking.

Learning the Practices of Scientific Inquiry. The Capabilities-with-Nature Approach to Science Education suggests that the central purpose of science education is to contribute to (a) developing students' capabilities that allow them to address their fundamental human needs as students and future adults; and (b) providing students with opportunities to enact such capabilities. Such a purpose orientation for science education provides *the* ultimate purpose of any practice of scientific inquiry in an educational context. For instance, in the current science curriculum for grades 5–8 in Manitoba (Manitoba Education and Training, 2000), the practice of scientific inquiry is divided into four steps (p. 2.5). The first step is the *purpose* of scientific

inquiry, which is "seek[ing] answers to questions that humans have about the natural world" (p. 2.5). Once particular questions are asked, the second step consists of *applying scientific inquiry strategies*, such as hypothesizing and experimenting, in order to answer the questions posed. The third step is then *the proposing of explanations* for the phenomena that the second step produced. The fourth step consists in the exploration of three possible parts: inquiring into new questions that arose from the explanations, and thus starting a new scientific inquiry; considering social applications and environmental implications of the explanations; and engaging in personal actions arising from the explanations. If we consider these four steps as *the* four steps of the practice of scientific inquiry, then the purpose orientation of the Capabilities-with-Nature Approach to Science Education suggests that each of these four steps is guided and framed by the ultimate purpose of science education described above. For the design of science teaching, it means that, when designing learning activities linked to each of the four steps of the practice of scientific inquiry, the core design question is "What capabilities that help students live a flourishing life can be addressed at this stage of the practice of scientific inquiry?" For instance, at the purpose stage, teachers can design activities to help students identify questions they might have about the natural world that directly affect their living a flourishing life. At the application stage, teachers can design activities that might help students understand the link between the explanations of natural phenomena they inquired into and the quality of their own lives.

Science Teacher Education for Well-Being

In terms of educating teacher candidates, it is, broadly speaking, necessary to consider exactly what to teach and how to teach it. Through the lens of science teacher education for well-being, we may also consider what capabilities teacher candidates require for their well-being, and by extension, what experiences (designed by the teacher educator) will help the teacher candidate to develop these capabilities. Science teacher education that aims to prepare teacher

candidates as instructional designers from the perspective of the Capabilities-Development-with-Nature Approach to Science Education would engage teacher candidates from the same premise outlined for the approach in the previous section: Science teacher education is education for teacher well-being, whereby well-being as a teacher encompasses their professional practice as a core aspect of their teacher life, as we will illustrate below. This is directly linked to the first and second theoretical principle of a Capabilities-Development-with-Nature Approach to Science Education, that is, in order for humans to live a flourishing life, they need to have capabilities that allow them to address their present and future fundamental human needs and to have opportunities to enact those capabilities. Teacher candidates need certain capabilities in order to help them fulfill their fundamental human needs and they require opportunities to develop those capabilities. We will provide some examples of such opportunities further below.

The importance of understanding human needs and the capabilities needed to address them within a socio-cultural context is another key theoretical principle. Through the science teaching design principles listed above, teacher candidates (the socio-cultural community) are involved in identifying an agreed-upon understanding of human needs and capabilities required of teachers of science. Such a discussion could take place on the first day of the course, or ideally before the course begins, perhaps through an online discussion.

Concerning the final theoretical principle, the question is: What might the importance of involving our relationship with the natural environment in the development of capabilities look like in the preparation of science teacher candidates? As with the design of science teaching in a K-12 setting, experiences for the development of teacher candidates' capabilities need to be designed wherever possible through engagement with the natural world. As science teachers, a relationship with nature that is based upon wonder, curiosity, and respect will enhance overall

well-being, in addition to the teacher's ability to teach science in a way that sparks awe and reverence in their students.

Teaching Science Education as Inquiry and Argumentation

We referred earlier in this chapter to the categorization of science teaching into three broad categories: learning of knowledge disseminated by scientists; learning the ways of scientific thinking; and learning the practices of scientific inquiry. The Capabilities-Development-with-Nature Approach to Science Education includes all three, with a focus on the latter, learning the practices of scientific inquiry. But what is meant by scientific inquiry in a pedagogical sense? Scientific inquiry provides students with opportunities to explore a problem, search for potential solutions, ask questions, make observations, test ideas and intuition, and participate in creative work (e.g., Gillies & Baffour, 2017). Pedagogically, providing opportunities to engage in scientific inquiry involves offering students experience in which they do the work of science, such as wondering about what they observe in their encounters with nature and natural phenomena and, in turn, developing questions about their wonderings, exploring possible ideas and explanations concerning their questions, expanding on scientific ideas and processes, and reflecting on their understandings with regards to discovered evidence. Based upon the educational theory of constructivism, teaching from a scientific inquiry approach involves: (a) presenting problems to students that confront their understandings about natural phenomena; and (b) considering whether their current thinking needs to be altered in light of evidence and research (e.g., Rennie, 2005). The teaching of scientific inquiry requires the skill, on the part of the teacher, to spark the students' curiosity concerning a subject of study and then to orchestrate experiences and opportunities to investigate the questions they have (e.g., Gillies et al., 2015).

Science teacher education has come to emphasize the value of involving students in the processes and practices of science, rather than focus on the testing of science concepts and

content (e.g., Schwarz, 2009; Simon et al., 2006). Consequently, science teacher education may ideally provide teacher candidates opportunities to develop understandings and strategies for teaching science to students by means of building an argument for an idea that explains a natural phenomenon. Scholars of science teacher education contend that presenting science-as-argument provides an effective framework for teacher candidates to conceptualize science pedagogy (e.g., Zembal-Saul, 2009). Through the lens of a science-as-argument framework, science teacher educators provide teacher candidates opportunities to consider and practice pedagogical approaches and experiences that allow for the practice of science.

Reframing Science Teacher Education to Serve the Purpose of Well-Being Education

Building upon the theoretical section of this chapter, we now consider how science education serves the purpose of well-being in teacher education. As the name implies, the Capabilities-Development-with-Nature Approach focuses on designing opportunities for children to develop capabilities through engagement with nature. How could science teacher education develop capabilities to support the goals of well-being education? One particular need required for teachers is professional autonomy and freedom. Freedom in this context may involve the freedom to make choices or develop awareness (Max-Neef, 1991, p. 33). What are the freedom-linked capabilities that future teachers may need? Here are a few examples:

- The capability to develop an awareness of the needs of a student.
- Linked to the previous one, the capability to design learning opportunities that support the needs of students in their learning and development.
- The capability to become aware and make choices from various research-based pedagogies in support of student learning and development.
- The capability to collaborate with students, teachers, Elders, parents, administrators, and community members and organizations, and then to make choices based upon that

collaboration (and the further awareness of the school, family, and community context) to support student learning and development.

- The capability to become aware and reflect upon one's teaching practice—to identify strengths and struggles and to act in such a way as to further develop and enrich one's own teaching practice.

For the teacher educator, the question then becomes how to design opportunities for teacher candidates to develop and enact these capabilities in support of their well-being. For each of the capabilities listed above, the teacher educator may carefully craft experiences that help teacher candidates consider the theoretical underpinnings of each capability (perhaps through a reading of a relevant article and subsequent in-class dialogue) and provide opportunities to practice the capability in either practicum settings or pseudo-situations within the science education classroom or lab. As an example, in design for opportunities to develop the capability to collaborate with parents and others, the teacher educator may begin by engaging the teacher candidates in a selection from the appropriate literature (e.g., Tali Tal, 2004) through a discussion. Afterwards, the development of this capability may be realized through the practice of a mock school-setting fishbowl discussion in which the teacher candidates divide into a number of groups, each respectfully representing one perspective of various vested members of the community (i.e., teacher, parents, Elders, principal, students, and so on). The teacher candidates would be provided with a description of the mock school and community highlighting specific needs, strengths, and characteristics. In their groups, teacher candidates would consider their assigned roles and create talking points to present respectfully their perspectives and ideas to contribute to the collaborative intent of supporting the needs of the students. One chair for each role would be placed in a circle and group members take turns representing their character while the teacher educator facilitates discussion.

In this experience, teacher candidates have the opportunity to develop the capability to collaborate with others from various perspectives within the school and the community. The capability to collaborate with others to support the needs of students is arguably an essential capability for a teacher, a capability that strengthens the teacher's ability to build awareness of the wider context of school, family, community, and culture, and subsequently contributes to the teacher candidates present and future well-being.

It is a common practice among post-secondary teachers, including teacher educators, to design their courses with learning outcomes or objectives in mind. In order to focus the efforts of a purposeful design towards teacher well-being, a familiar approach is to use learning outcomes to highlight the development of capabilities. For example, a freedom-linked learning outcome on a science education course outline may read something like, "by the end of the course, the teacher candidate will be able to make choices about pedagogical approaches to teaching with nature." The purpose of this outcome may be made explicit either through discussion with the teacher candidates at the outset of the course or by extending the outcomes statement to include the intention. By highlighting and designing our teacher education curricula for teacher well-being, teacher education programs may contribute to the flourishing and well-being of teacher candidates both in their lives as students and their future careers as teachers. Notably, the modelling of the Capabilities-Development-with-Nature Approach within a teacher education program gives teacher candidates the opportunity to experience a pedagogical approach that may also benefit their own students.

We have argued here that well-being may be met when human needs are satisfied. When teacher educators design experiences and opportunities to develop and enact capabilities that satisfy basic human needs, teacher candidates may flourish. This is the primary focus of a Capabilities-Development-with-Nature Approach.

Conclusion

In this chapter we have outlined the theory and illustrated the practice of a particular approach to science education—the Capabilities-Development-with-Nature Approach to Science Education—and its implications for purpose-focused instructional design thinking in science teaching and science teacher education. The approach takes its starting point in the premise that education is first and foremost about opportunities to develop and engage capabilities that allow the learner to live a flourishing life (a life of well-being). This premise together with a particular understanding of what it means to live a flourishing life have specific implications for curriculum designing with respect to each of the three general goals of science education, which we illustrated in this chapter: learning of knowledge disseminated by scientists, learning the way of scientific thinking, and learning the practices of scientific inquiry. Finally, the premise about the primary purpose of education has the same general implications for science teacher education, and this chapter provides some examples of such implications.

As with any other subject-specific school education, science (teacher) education and the work of teachers as curriculum designers cannot be separated from the core purpose(s) of school education. In this chapter, we have illustrated how design thinking in science (teacher) education is impacted by a specific response to the question about the core purpose of school education.

References

Brighouse, H. (2006). *On education*. Routledge.

Brown, T., & Kātz, B. (2009). *Change by design: How design thinking transforms organizations and inspires innovation*. Harper Business.

Carlgren, I. (1999). Professionalism and teachers as designers. *Journal of Curriculum Studies, 31*(1), 43–56.

Cross, N. (2011). *Design thinking: Understanding how designers think and work.* Berg Publishing.

DeBoer, G. (1991). *A history of ideas in science education: Implications for practice*. Teachers College Press.

Donovan, M.S., & Bransford, J. D. (Eds.). (2005). *How students learn: Science in the classroom*. The National Academies Press.

Duschl, R., Schweingruber, H. A., & Shouse, A. W. (Eds.). (2007). *Taking science to school: Learning and teaching science in grades K-8*. The National Academies Press.

Edwards, C., Forman, G., & Gandini, L. (2012). *The hundred languages of children the Reggio Emilia experience in transformation* (3rd ed.). Praeger.

Falkenberg, T. (2019). *Framing human well-being and well-becoming: An integrated systems approach*. http://wellbeinginschools.ca/paper-series/

Falkenberg, T. (2020). An ethic of sustainable well-being and well-becoming: A systems approach to virtue ethics. In H. Bai, D. Chang, & C. Scott. (Eds.), *A book of ecological virtues: Living well in the Anthropocene* (pp. 157–177). University of Regina Press.

Fraser, S. (2006). *Authentic childhood: Experiencing Reggio Emilia in the classroom* (2nd ed.). Nelson.

Gillies, R., & Baffour, B. (2017). The effects of teacher-introduced multimodal representations

and discourse on students' task engagement and scientific language during cooperative, inquiry-based science. *Instructional Science*, *45*(4), 493–513. https://doi.org/10.1007/s11251-017-9414-4

Gillies, R., Nichols, K., & Khan, A. (2015). The effects of scientific representations on primary students' development of scientific discourse and conceptual understandings during cooperative contemporary inquiry-science. *Cambridge Journal of Education*, *45*, 427–449. https://doi.org/10.1080/0305764X.2014.988681

Heard, G., & McDonough, J. (2009). *A place for wonder: Reading and writing nonfiction in the primary grades*. Stenhouse Publishers.

Henriksen, D., Gretter, S., & Richardson, C. (2020). Design thinking and the practicing teacher: Addressing problems of practice in teacher education. *Teaching Education, 31*(2), 209–229. https://doi.org/10.1080/10476210.2018.1531841

Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.

Lawson, B. (1980). *How designers think: The design process demystified*. Architectural.

Link, M. (2018). *Nature, capabilities, and student well-being: An evaluation of an outdoor education approach* [Doctoral dissertation, University of Manitoba]. http://hdl.handle.net/1993/33289

Manitoba Education and Training (2000). *Grades 5 to 8: Manitoba curriculum framework of outcomes*. https://www.edu.gov.mb.ca/k12/cur/science/outcomes/5-8/full_doc.pdf

Mingers, J. (2006). *Realising systems thinking: Knowledge and action in management science*. Springer.

Nussbaum, N. C. (2011). *Creating capabilities: The human development approach*. The Belknap Press of Harvard University Press.

Orr, D. W. (1991). *Earth in mind: On education, environment, and the human prospect*. Island Press.

Pedaste, M., Mäeots, M., Siiman, L., de Jong, T., van Riesen, S., Kamp, E., & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational Research Review*, *14*(C), 47–61. https://doi.org/10.1016/j.edurev.2015.02.003

Razzouk, R., & Shute, V. (2012). What is design thinking and why is it important? *Review of Educational Research*, *82*(3), 330–348.

Rennie, L. (2005). Science awareness and scientific literacy. *Teaching Science*, *51*(1), 10–14.

Roman, A. (2018). *Thinking-driven testing: The most reasonable approach to quality control*. Springer.

Schumacher, E. F. (1999). *Small is beautiful: Economics as if people mattered*. Hartley & Marks.

Schwarz, C. (2009). Developing preservice elementary teachers' knowledge and practices through modeling centered scientific inquiry. *Science Education*, *93*, 720–744.

Simon, S., Erduran, S., & Osborne, J. (2006). Learning to teach argumentation: Research and development in the science classroom. *International Journal of Science Education*, *28*(2–3), 235–260.

Tali Tal, R. (2004). Community-based environmental education: A case study of teacher-parent collaboration. *Environmental Education Research*, *10*(4), 523–543.

White, J. (2011). *Exploring well-being in schools: A guide to making children's lives more fulfilling*. Routledge.

Zembal-Saul, C. (2009). Learning to teach elementary school science as argument. *Science Education*, *93*(4), 687–719. https://doi.org/10.1002/sce.20325