ACADEMIA Letters

Thinking now: Transdisciplinary thinking as a disposition

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There is general consensus that current education must include the 21st Century skills such as communication, collaboration, creativity, critical thinking, ICT (information and communication technology), and cross-cultural understanding (Chu et al., 2017; OECD, 2020). In their white paper for the South Australia Department for Education, Butler and Clapton-Caputo (2015) wrote that thinking should be interpreted through the lens of 21st Century competencies/capabilities. Such thinking involves three domains: critical, creative and digital. The three are integrated with the goal of teaching students not only to use technology but to critically analyse current applications and to create new tools.

While we agree with Butler and Clapton-Caputo, we believe that navigating the globalized technological world of today, let alone of the unimaginable future, requires a disposition that encourages students to make connections across all of their learning. We put forward that transdisciplinary thinking, functioning as a disposition, provides a rich context for the effective application of the 21st Century competencies.

What is transdisciplinary thinking and where is it found

Interdisciplinarity is generally understood to mean connections across established disciplines; transdisciplinarity goes beyond the disciplines (Drake & Reid, 2020; Guimaras et al., 2019). The best way to understand transdisciplinarity is to see its application in various contexts:

The International Baccalaureate Primary Years Programme (IB PYP) takes a transdisciplinary approach "to convey that learning has relevance across subject areas and more importantly, the learning transcends the confines of subject areas to connect us to what is real in the world" (IBO, 2012).

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- Brock University describes its transdisciplinary research program as "bridging disciplines to come together to solve complex problems....to better tackle pressing contemporary issues and generate knowledge...transdisciplinary work reflects the reality that, for any complex problems, the total truly is greater than the sum of its parts" https://brocku.ca/research-at-brock/institutes-and-centres/.
- In the health field, transdisciplinarity transcends traditional boundaries to integrate the natural, social and health sciences in a humanities context (Choi & Pak, 2007). The intention is to resolve complex real-world issues and allow for different perspectives on research questions.
- In agriculture, the use of big data to study pig husbandry capitalizes on transdisciplinary research "to create new knowledge which contributes to societal progress..." (Faverjon et al., 2019).
- A geographic information system (GIS) technology is used by over 350,000 organizations for such things as disaster response, public safety, and health and social equity (Dangermond, 2020). The software reveals patterns, visualizes trends, and provides a way to explore vast quantities of information holistically by making explicit the layers and layers of connections. This transdisciplinary look at data can transform the way we make decisions about nearly everything.

Such disparate contexts share common ideas. Transdisciplinary work is **holistic** (It is synthetic in nature; it transcends disciplinary boundaries.); **creative** (The result of transdisciplinarity is the generation of new knowledge or at least a new combination of established knowledge.); and **relevant** to real-world issues (It reflects the multi-formed nature of reality itself).

Transdisciplinarity as skill set and a disposition

Some theorists describe transdisciplinary thinking as a set of skills. For example, researching creativity, Henricksen (2016) found that award-winning teachers shared a set of common habits of mind that she identified as transdisciplinary cognitive skills. These skills were observing, patterning, abstracting, embodied thinking, modelling, play and synthesizing. Similarly, one of five skillsets within the IB PYP transdisciplinary framework identifies thinking skills as including comprehension, application, analysis, synthesis, dialectical thought, and metacognition (McGuinness, Swartz, & Sproule, 2016).

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While we endorse the notion that the skills listed above are essential subsets of 21st Century thinking skills, we see transdisciplinary thinking as a mindset, a habit of mind and behaviour. Because transdisciplinary thinkers actively seek connections across disciplines and areas of expertise, they are not at all surprised to find them. In the transdisciplinary mind, knowledge is rethought, revealed, recombined, transformed. In short, we see transdisciplinary thinking as a mental or intellectual disposition towards *intentional* connection-seeking and connection-making. It is a meta-level attitude.

If we accept transdisciplinary thinking as a disposition, then we should accept that it can be taught. Dispositions such as taking responsibility, showing initiative, and collaboration are already being taught and assessed (see, for example, Ontario Ministry of Education, 2010). The IB Learner Profile describes the broad range of capacities that thread through all IB programs around the world (https://www.ibo.org/benefits/learner-profile). IB learners are to become open-minded, reflective, and inquirers, among other traits. Finland and China include citizenship and personal and social responsibility in their curricula (Wang, Lavonen & Tirri, 2018). Thus, we see that education is already in the business of cultivating dispositions.

Wicked problems and teaching a transdisciplinary disposition

A wicked problem is a problem so complex and possibly unsolvable that it requires approaching the issue collaboratively using multiple lenses. Ending poverty, achieving gender equity and ensuring food security are excellent examples of wicked problems identified in the United Nations 17 Sustainable Development Goals (https://www.un.org/sustainabledevelopment/). Wrestling with such multifaceted issues requires a transdisciplinary thinking skillset and a disposition/mindset.

To start the teaching process, the teacher and/or students create a web (Figure 1), beginning with identifying a real-world issue/topic (not a discipline) that is relevant to students. The topic may be seemingly mundane such as videogames or cars, or it may be an obvious wicked problem such as climate change. Students identify categories for brainstorming and investigating to surround the central topic; the categories can be flexible but need to be broad, diverse, and based in the real-world. The disciplines will be embedded in the collected research, but they are not the starting point.

Each student (or group) chooses one category for research. They critically analyze and evaluate their information. That research can be shared to prepare for the next step of connection-seeking. Individually or collaboratively, students explore connections across the categories on the web. The jigsaw strategy works well for this (see. https://www.teachhub.com/teaching-strateges/2-16/10/the-jigsaw-method-teaching-strategy/).

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Figure 1: An example of a transdisciplinary real-world web

By investigating each category and then making connections across categories, students see how a seemingly small topic such as "shampoo" explodes into a myriad of potential areas of investigation and connection: health and safety, animal rights, gender beauty ideals, marketing, chemicals (e.g., dye, phosphates), plastic waste, patents, international corporations, fair trade - where to stop? And then, what connects to what? As <u>Rosenfield (1992)</u> wrote, a "transdisciplinary approach can provide a systematic, comprehensive theoretical framework for the definition and analysis of the social, economic, political, environmental, and institutional factors influencing human health and well-being" (p. 1343).

This systems thinking can be done in a visible manner using yarn or drawing lines on a paper web or a digital mind map. Throughout, students are encouraged to be on the lookout for intersections and relationships - in short, to develop their transdisciplinary mindset. This process demands, at the very least, the 21st Century skills of inquiry, communication critical thinking, collaboration, creativity, and transdisciplinary thinking.

Here's how it went in an actual classroom. At the end of the mapmaking, the Grade 9 classroom floor was a web of crisscrossed yarn. Susan asked the students: "Ok - so what is connected?" There was a pause followed by a moment of surprise and awe. The answer? "Everything".

Teaching transdisciplinary thinking as a disposition complements the 21st Century skills and develops the mindset needed for global citizenship. Once students can think in transdisciplinary ways they learn to expect and respect multiple perspectives. When students research, reflect and apply systems thinking, they are better able to critique the transdisciplinary wicked

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problems that await them in the real world.

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