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Water education, ocean literacy and arts integration

A literature review in an interdisciplinary team

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Abstract

Life below water, as well as *at* waters, is threatened due to human activity that has caused global warming. As UNESCO stresses, "the time to learn and act for our planet is now". This article reports on a literature review of existing action research on water education, ocean literacy and arts integration carried out by an emerging interdisciplinary research group stretching across the fields of marine science, arts and science education. Joined by a concern for water education and ocean literacy,

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the interdisciplinary teams screened 368 research articles with the assistance of the program Covidence which helps with streamlining the literature review processes in a team. Ending up with 14 relevant articles that were analysed in-depth, the authors argue that arts-integrated water education projects take place locally across higher education, formal education and informal education in collaborative teams. The action research projects screened promote and develop open-ended, inquiry-based and creative pedagogies, seeking to foster the capacity to act for sustainable living in a more-than-human world. However, all research projects screened in the review seemed to develop water education more generally. There is a lack of literature researching how the connection to ocean literacy including *life below water specifically*, can be nurtured.

Keywords: water education, oceans literacy, arts integration, inter-disciplinarity, literature review, life below water, sustainability

> *Oceans are large and lively reservoirs of water. Oceans are alive through chemical processes such as ocean acidification and de-oxygenation, as well as physical processes in current systems, changes in salinity, stratification, storm patterns, temperature and changing lights. Oceans are in constant movement, circulating and washing up water, organisms and human made materials on ever new coastlines. Oceans are watery, as is the human body, and connect oceans directly to human life, and to the hope that both water and humans carry.*

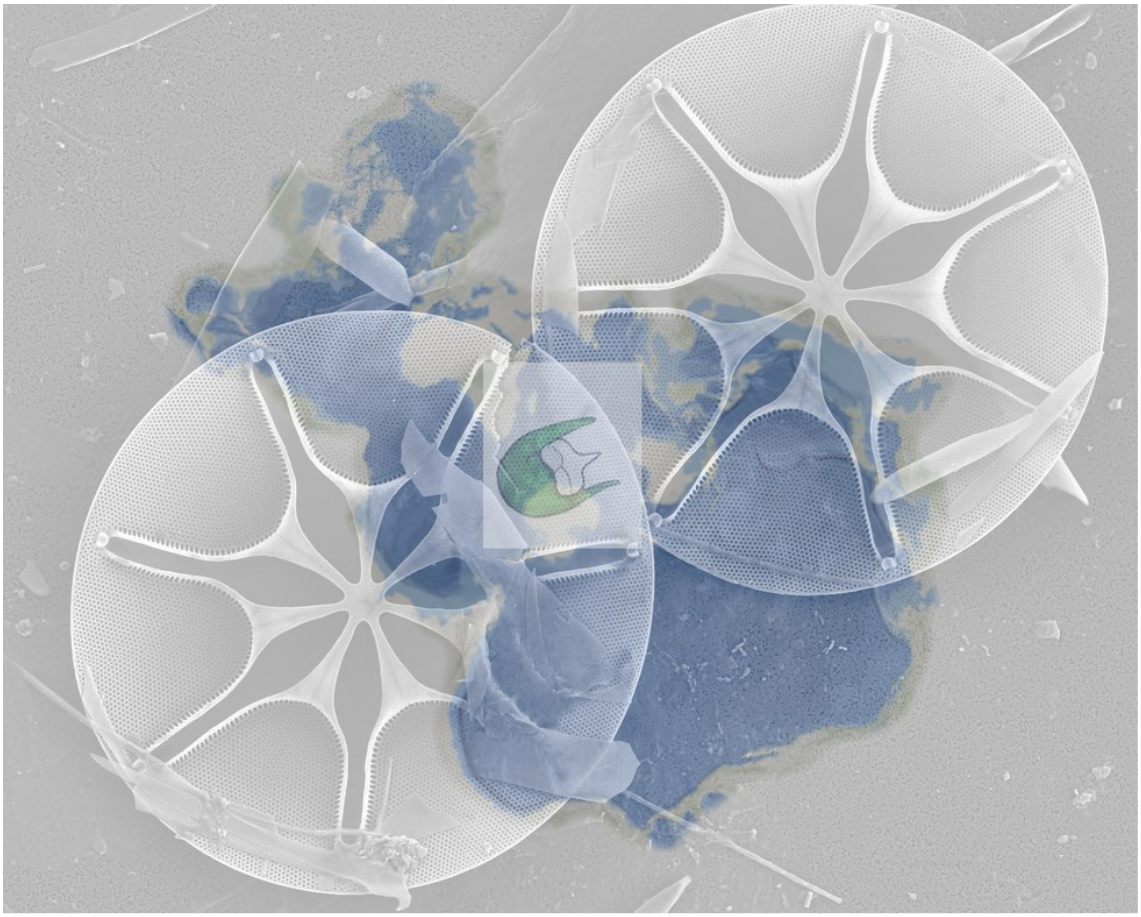

Figure 1. Life below water. The picture, a pennate diatoms has been taken by an electron microcopy by marine biologist Nihayet Bizsel. Design by Manola Gayatri Kumarswamy.

Research context and questions

This article reflects the coming together as an interdisciplinary research group through the undertaking of a joint literature review. Our disciplines that we bring into the group stretch across marine science, arts and science education. We are joined by a concern for water education, ocean literacy and arts in education. The idea to form an interdisciplinary research group was propelled by UNESCO's policy document which underlines that "[T]ransformative learning for people and the planet is a necessity for our survival and that of future generations. The time to learn and act for our planet is now" (UNESCO, 2021, unpaginated).

The author team consists of researchers originating from Finland, Portugal, South Africa, Kurdistan, India, New Zealand, Australia and Spain – geographical areas where waters are affected very differently by global warming. During the writing of

this article we were all employed at universities or municipalities in Norway, South Africa and New Zealand, and we found one another through participation in different existing research networks concerned with the oceans. The idea that we could become an interdisciplinary team that builds on, and promotes, arts, science, and education working for the development of water education arose out of our initial discussions. We found that we, as a group, hold expertise that is truly interdisciplinary. This interdisciplinarity might be beneficial for the innovation and transformative learning UNESCO asks for (2021). The knowledge needs as articulated by UNESCO are large, compelling and *need interdisciplinary solutions* [emphasis added]. This author team is highly interdisciplinary:

Tone Pernille Østern is a senior researcher with expertise in arts and science combined participatory action research projects (Østern & Strømme, 2014; Østern et al., 2019). Helena Bichao holds expertise in biology, coastal ecology, and learning by drawing. Carol Preston contributes expertise in arts-based research, play-making and puppetry, and previous experience with water related arts educational research. Murat V. Ardelan is a senior researcher, leading the NTNU Marine chemistry and biogeochemistry group research cruising in waters worldwide (Ardelan et al., 2010, Sanchez et al., 2019,). Manola Gayatri Kumarswami contributes expertise in the Indian performance format, Rasa, as well as the watery visual expressions used in this article. Rose Martin is a senior researcher, with expertise in arts education, inclusion, community, diversity and equity (Martin, 2016; Martin & Anttila, 2018). Ralph Buck is a senior researcher, and the UNESCO Chair for Dance and Social Inclusion holder, with expertise in the integration of science and arts (Buck & Snook, 2016, 2017). Maria Azucena Gutiérrez González has experience from being the NTNU Oceans Coordinator for Research and Education, holding expertise in knowledge transfer, interdisciplinary brokerage, international project management, and communications.

To find out how we as an emerging interdisciplinary research group could design an imaginary future research project, we needed to start with reviewing existing research. And before we could do a review, we needed to draw boundaries around a field we were interested in and might be able to contribute to in the future. Thus, we decided to start with a literature review. Patricia Alexander (2020) writes that when it comes to systematic literature reviews “authors’ theoretical orientations are likely reflected in the topics or issues they find intriguing and worthy of pursuit” (p. 9). For us, through our initial discussions taking place on Zoom, *water education, ocean*

literacy, and *arts integration* became these theoretical orientations. They are defined later in the article.

To sum up, in order to create an interdisciplinary research group across the fields of marine science, arts and science education, joined by a concern for water education and ocean literacy, we started with a systematic review of existing research. This article reports on that review. The results of the review will guide our next steps as an emerging research group, however, that future imaginary participatory action research is not the focus of this article. This article merely reports on the review we did as we were becoming a team. The following review questions guide our review, and thus this article:

- In what ways are working methods similar to arts integration, defined in interdisciplinary projects in educational contexts?
- In what cultural and educational contexts are research projects where water education and/or ocean literacy are developed through arts integration found?
- What activities are developed in research projects where water education and/or ocean literacy are developed through arts integration?
- What are the results of research projects where water education and/or ocean literacy are developed through arts integration?

The literature we present in this article is not specifically about life below water, but about water education more generally, since that is what we found. However, our concern that sets this project in motion is connected also to life below water, and we believe that any positive outcome of water education can be linked to a positive – however small – influence on that life. To stay connected to this ocean depth world is so easy to forget for earth surface living human beings, thus throughout the article we will weave in life below water marine science narratives in the text. These watery science stories are composed by authors Ardelan and Kumarswami engaging in interdisciplinary dialogues across marine chemistry and Indian performance arts and will be marked with italics and coloured blue.

> *In the open sea the microscopic phytoplankton captures sunlight and uses its energy to fix CO2 from the atmosphere into rich organic compounds that become food for all creatures depending on them. By doing this*

> *conversion phytoplankton produce another important molecule: oxygen. Phytoplankton floats around and is totally dependent on water movements. Besides supplying the essential food for their predators, they also have a very crucial role while they are sinking down to the deep ocean; they are pumping CO2 from the atmosphere into the deep ocean and the bottom of the sea. Very tiny portions of the organic carbon they create are buried in the sediment and then move deeper in the crust. It eventually transforms into sticky viscous liquids (oil) by the help of high temperature and pressure in the geological structure under the sediment.*

In the following, we describe the theoretical concepts and values that create the boundaries for our literature review. After that, we describe the methodology used. Following that, we present the four main discoveries we made through our review. Finally, we discuss our discoveries, and look towards an imaginary future project.

Environmental education theoretical concepts and values that frame the review

The theoretical concepts of *ocean literacy*, *water education* and *arts integration* are central for the review that this article reports on. Further, we see that our pre-understanding that any action taken must aim towards *eco-systemic transformation* within a philosophy of *ecomorphism* acts as parameters for the formulation of these theoretical concepts. In the following we will define these five concepts, which can be understood as educational values underpinning the review.

Water education

A recently released UN report on climate change makes it clear that human activities have warmed the atmosphere, oceans and land (IPCC, 2021). Water is threatened because of human activity and water is now at stake for humans and non-humans in a more-than-human world. Life below water is specifically inhabited by other-than-humans, however, these species are severely threatened because of human activity, as are also humans themselves. We are all materially watery, and neither humans nor other-than-humans can live in a waterless world. The UN has thus initiated the

Decade of Oceans Science for Sustainable Development 2021-2030[2] with the motivation to:

> … support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean. (United Nations Decade of Oceans Science for Sustainable Development 2021-2030, n.d., unpaginated)

Sustainable water education is a key UNESCO focus area. One result of quality water education is *ocean literacy* [our emphasis]. The need to create awareness through high quality water education resulting in ocean literacy is urgent (Ferreira et al., 2021)

Ocean literacy

The Oceanographic Commission defines *ocean literacy* as "an understanding of the ocean's influence on you and your influence on the ocean" (Intergovernmental Oceanographic Commission, n.d., unpaginated). The Oceanographic Commission states that an ocean-literate person:

- understands the essential principles and fundamental concepts about the ocean;
- can communicate about the ocean in a meaningful way; and,
- is able to make informed and responsible decisions regarding the ocean and its resources. (unpaginated)

Education, interdisciplinary and international collaborations and young people provide the 'swell' of the Oceanographic Commissions notions of ocean literacy. UNESCO (2012, 2015) has focused on capacity building and water-related education for sustainable development over the past decades, and specifically notes that water education must happen over a broad specter of educational platforms: in school

[2] See https://en.unesco.org/ocean-decade and https://www.oceandecade.org/

curriculums, in higher, professional and vocational education, and in collaborative ways across disciplinary boundaries (UNESCO Children and Youth, n.d.). Arjen Wals underlines that environmental education to bridge a troubled planet cannot go about business as usual, but needs a radical relational perspective (Wals, 2022, unpublished keynote presentation). Wals promotes *arts-based pedagogies* and learning as central in a needed shift towards inquiry-based, value-based and place-based transformative learning, and towards citizen science [our emphasis].

Arts integration

Arts integration means that arts are integrated into other subjects to promote learning in both arts and the other subject(s) (Jusslin, 2020, p. 186). Arts integration develops arts-based methods, which we understand as activating and pedagogical forces promoting indeterminacy and openness for spaces of transformation. A comprehensive international review of arts and science integration within schools (Green et al., 2018) found that arts integration improved science academic performance as well as general use and understanding of science vocabulary. Ralph Buck and Barbara Snook (2016) found improved understanding of science concepts within their New Zealand based arts and science combined study. Previous research combining arts and science in creative practices further demonstrates a significant opportunity to develop the emotional and behavioral foci in educational programs and projects (Buck & Snook, 2016; Green et al., 2018; Ward, 2005; Winks et al., 2020; Østern & Strømme, 2014; Østern et al., 2019). The arts can play an inclusive, dynamic, and leading role in engaging children and young people's visions for the valuing of water in sustainable ways that are relevant to those children's and young people's cultural and geographical contexts. Arts and science combined might play a crucial role in moving water education and ocean literacy to the forefront.

Eco-transformative change within a philosophy of ecomorphism

Our emerging formation of an interdisciplinary research group is based in a joint value ground aiming at *eco-transformative change*, which goes hand in hand with a relational educational philosophy. All change happens in ecological systems. Oceans are alive together with all life on Earth, including humans, in pervasive ways. Thus, this research finds its place within a philosophy of *ecomorphism*, which according to Karen Malone and Sarah Jane Moore (2019, p. 10) "supports a view of humans as interdependent with all ecological beings, objects and weathering of the earth". They go on to argue that this form of ecomorphism "attributes the qualities of having a shared life through sensorial knowing with others and objects, whether they be

human or nonhuman" (p. 10). To support radical change aiming at eco-transformative change, Heila Lotz-Sisitka (2018) argues that environmental education needs to develop as transgressive transformative learning, standing on the pillars of transformation, transgression, transdisciplinarity, and togetherness. She defines transgressive learning as

> /…/ a form of transformative learning that intentionally generates critical thinking, collective agency, and changes in practice and structure. It challenges that which is normalised, especially those practices that lend themselves to the reproduction or recycling of the same knowledge and practices generation after generation. (Lotz-Sisitka, 2018, May 30).

Summing up, as we have drawn the boundaries of this literature review, key parameters we have looked for in the research we have reviewed are: action research that brings young people's voices and experiential learning into the heart of action; action research that strives towards transgressive transformational learning with the aim of sustainable eco-systemic transformation, and; action research that aims at radically changing water education as a way to foster ocean literacy through arts integration.

This literature review – methods and procedures

This review follows the procedures of a systematic approach to literature reviews as described by Alexander (2020) and Andrea Booth et al. (2016). Alexander (2016, p. 6) offers methodological guidance as to ensure quality of such reviews through articulating a number of challenges: framing challenges, procedural challenges, consolidating and summarizing challenges, and finally, interpreting and communicating challenges (p. 7). Responding to framing challenges, we have in the previous sections articulated research questions to navigate our review, as well as the theoretical concepts and educational values that guide us in that navigation. According to Alexander (2020, p. 7), procedural challenges include formulating appropriate search criteria and justifiable inclusion and exclusion criteria. Central search concepts in our review have been *water education*, *ocean literacy, arts integration, eco-systemic transformation*, *action research*, *arts and science education combined, and children and young people's voices and activism.* Having tried several search engines, we decided to focus on ERIC only for this review, based on the discovery that there is a lot of overlap in the hits from different search engines. However, on a critical note, we admit that the results of this review clearly have an

Anglo-American bias. ERIC is frequently used by educational researchers, however, ERIC is sponsored by the Institute of Education Sciences of the U.S. Department of Education, which explains the Anglo-American bias. In addition, we have reviewed only literature written in English, although this research team could have also reviewed literature in several other languages.

For systematic procedures, we utilized Zotero[3] as a digital research assistant to download our hits and make a bibliography for the review. Further, to scan and review the hits, we utilized Covidence[4], a program that helps streamlining and organizing literature review processes in a research team. Before starting the review process, we set up inclusion and exclusion criteria that all reviewers followed. These criteria are displayed in Figure 2.

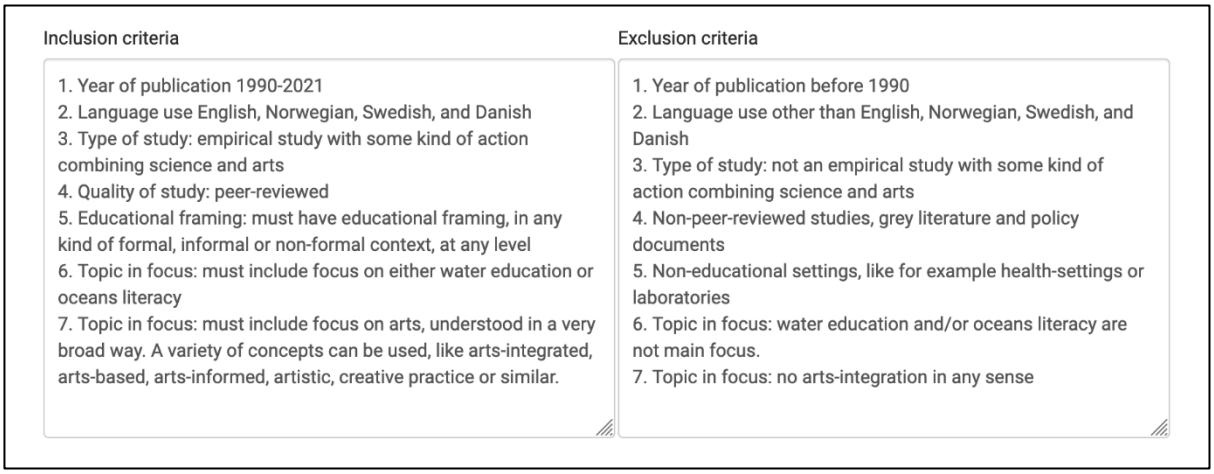

Figure 2. The inclusion and exclusion criteria for articles used in the screening process

After the abstract screening process, a full-text review screening continued, through the same logic. This was still a superficial reading of the full texts, to evaluate whether they fulfilled the inclusion criteria. From this stage, 36 articles were identified as relevant and transferred to the next stage for in-depth reading for a final evauation on whether to include or exclude the articles as of special relevance for this review.

[3] https://www.zotero.org/

[4] https://www.covidence.org/

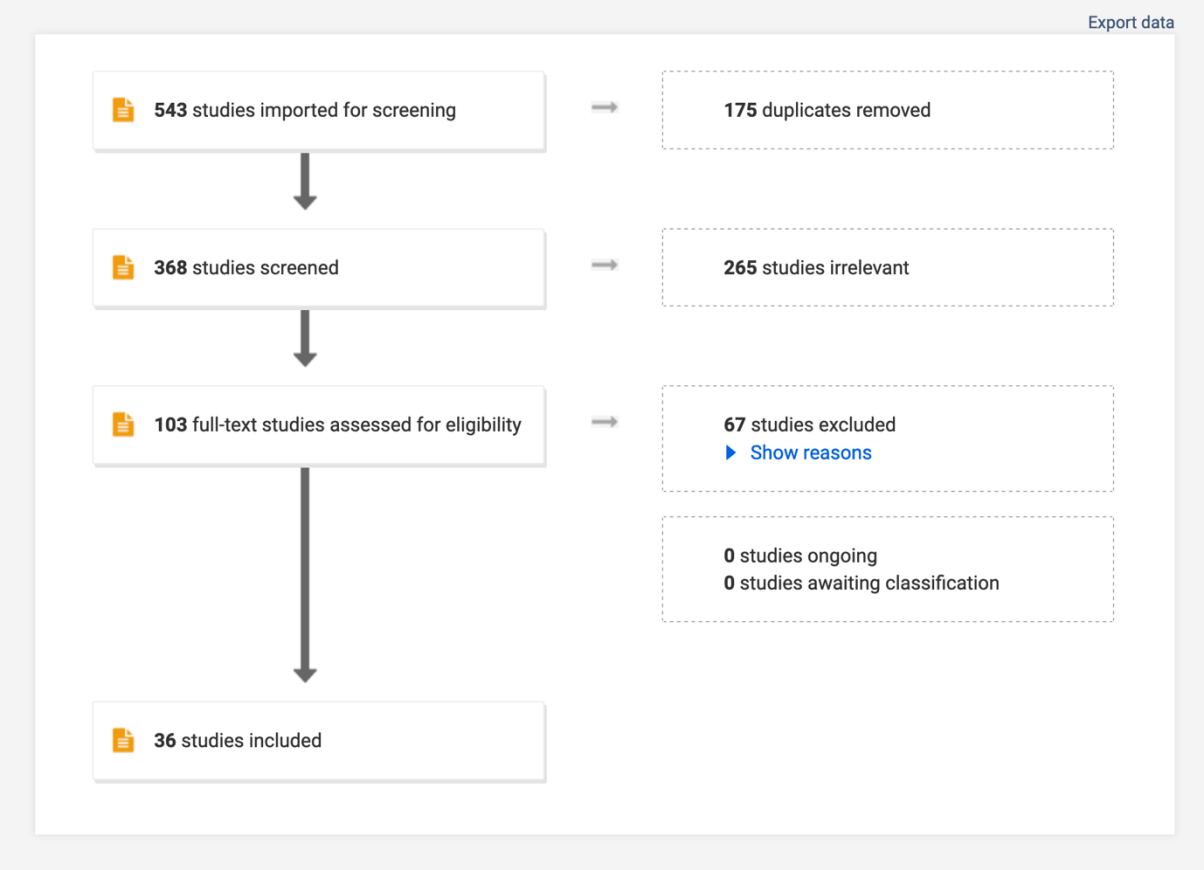

Figure 3. A covidence PRISMA flow chart showing our screening process based on inclusion and exclusion criteria for the review.

Figure 3 shows a Covidence generated PRISMA flow chart of our review process, ending in a selection of 36 research articles that we have read in-depth. Of these, we included 14 articles as relevant, meeting the inclusion criteria in full. In the remaining part of this article, we present what we found through the analysis of these 14 research articles, guided by our four questions that were initially set up for the review.

Discoveries: making watery connections across 14 studies

Of the 14 articles that fitted with our inclusion criteria (see Figure 2) and that we analysed in-depth, eight are conducted in the USA, two in Australia, one in Peru, one in Greece, one in Turkey, and one in the U.K. They are all published in peer-reviewed educational publication channels, covering disciplines of general education, science education, environmental education, and arts education. They are all published between 2006 and 2021, with the mean publication year in 2017. It is possible to gain a grasp of a pattern of similarities as well as differences regarding these 14 articles.

Review question two (in what cultural and educational contexts are research projects where water education and/or oceans literacy are developed through arts integration found?) can be answered across all fourteen articles, as there are clear similarities, with some exceptions. Research question one (in which terms are working methods similar to arts integration defined in interdisciplinary projects in educational contexts?), three (what activities are developed in research projects where water education and/or ocean literacy are developed through arts integration?) and four (what are the results of research projects where water education and/or ocean literacy are developed through arts integration?) depends on where the project "sits": within science education, within arts education, within environmental education, or within indigenous methodologies and theories. In the following we present what we discovered across our in-depth analysis of these 14 included articles.

Educational water projects across a range of stakeholders in participatory teams

In response to the question "in what cultural and educational contexts are research projects where water education and/or oceans literacy are developed through arts integration found", the projects that the 14 reviewed research articles present use methodologies that indicate collaboration. Methodologies such as participatory action research, arts-based qualitative (case) studies, educational design studies, and sometimes, but more rarely, mixed-methods combining quantitative and qualitative methods are used in the studies. Through such methodologies, the projects are clearly positioned in and connect to local contexts. The studies are initiated by researchers in higher education, but often the collaborations have grown slowly through formal or informal meeting points between the different participants. The researcher(s) then form a research team with local schools, various local stakeholders such as nature centers, water heritage museums or water protection associations, as well as local artists. In several of the projects a concrete arts result is produced, which remains in the community after the project, such as a a sculptural element in a schoolyard made of children's clay tiles about stories of water which at the same time function as water management on site (Carrie, 2015), comic booklets for children to read (van Bressem et al., 2006), a mural painted onto movable canvas that hangs on a public wall (Schneller et al., 2021), or a participatory performance (Schlemmer et al., 2017). Typically, in these projects, higher education researchers provide teachers with open-ended ways of thinking and working, whereas the teachers develop their specific teaching themselves. In most of the projects, artists are part of the research team. Collaborations are characterized by democratic ways

of working together. Top-down methods are resisted in the teaching philosophies as well as in the research teams themselves. The research projects thus practice what they teach: open-ended, creative and inquiry-based pedagogies. There are a lot of collaborations with local non-formal educational stakeholders, such as the local Water Education Trust (Townsend et al., 2015) or a local nature reserve (Miller & Cardamone, 2021). These stakeholders often join with teachers and researchers in wanting to develop innovative, interdisciplinary approaches to water education. Several of the projects specifically create practices to establish educational programs (for example van Bressem et al., 2006) or a curriculum development partnership between the third sector, higher education and schools (for example Townsend et al., 2015).

Arts integration to learn defined water content within science education

Two of the projects reported in articles selected for this review originate within science education. They utilize arts integration as a way of exploring how effective these creative approaches are when teaching young children the water cycle. One of the articles explores a specific talking drawing technique (Ahi, 2017), whereas the other more broadly includes different arts-methods such as painting, drama and design (Smith & Samarakoon, 2016). Arts and science integration is, in one of the articles, defined as how teachers should attempt to deliver problem-based lessons, promote creativity and encourage students to engage in experiments and take risks while doing so (Smith & Samarakoon, 2016). The studies evidence the efficacy of using art forms in environmental education, specifically in the teaching of scientific knowledge. The use of the drawing methodology, which included talking about the drawings, was clearly effective (Ahi, 2017). Findings in the study by Latisha Smith and Deepanee Samarakoon (2016) revealed that arts integration was motivating, engaging for the students, and a more effective strategy for teaching about the water cycle providing deeper insights about student understanding and misconceptions in science than in traditional forms of assessment.

Environmental and arts education combined fostering transgressive learning

The majority of the 14 articles that we have included are initiated from either environmental education researchers or arts education researchers. Although these thereby sit within different subject disciplinary contexts, on a spectrum with variations, they are united by seeking to develop pedagogical, environmental and arts educational values through their actions. The actions developed go deeply into a chosen water educational content, and water educational knowledge is indeed

developed. However, in the environmental education-initiated studies, water is more an example of a topic, and could have been substituted with any environmental issue. The goal is to develop inquiry-based and open-ended teaching strategies that more deeply might lead to education for sustainable development than traditional science education prescriptive and top-down approaches do. In one environmental education-led study environmental filmmaking was explored as more effective pedagogy than standard classroom lessons for developing environmentally responsible behaviour (Harness & Howard, 2011). In another environmental education-initiated study, underwater photograpy was used as an experiential marine education technique (Andrews et al., 2018). This approach turned out to be effective in fostering a sense of connection to the ocean.

> *Deep sea is more than surprising regarding diversity of life. It might even be called the cradle of life; the life of the most primitive organism may have started near to hydrothermal vents, where magmatic energy from the center of the Earth is available. On the contrary to life that evolved at the surface of the sea, deep sea life is not dependent on solar energy. That is why the start of the life-chain in the deep, deep dark ocean was, and still is, chemosynthetic.*

Also in the arts educational initiated project, the concern for water is real, but water is again more an example of a topic that offers possibilities to utilize and develop artistic and arts educational strategies to connect, engage, open, provoke and take action that could be utilized for any environmental issue. In one arts education-led study, the so called Get Wet project, the research was designed as a multi-site action research project, with the intention that teachers would work with university representatives and artists to develop new pedagogical approaches for teaching about water use and management that both embraced the creative aspirations of the project and made use of the local water museum heritage as a resource (Townsend et al., 2015). The project used arts installation as provocation, and the authors argue that provocation is as an example of a strategy that the arts offer. Beginning a learning project with provocation might mean to start with an unexpected event or object to stimulate imagination, open-ended thinking, discussion and play (Townsend et al., 2015). Another study defines the use of arts in a project called Water Stories, seeking to connect students and the larger community to water and landscape at the school, as a way of offering a creative process combined with learning, rooted in environmental sensitivity and awareness (Carrie, 2015). Such classes are believed to

empower people to shape their world. Several studies activate questions of social justice and equality as part of the water education project, as for example the project called the Ecosystem Pen Pals. This was an ocean literacy program for 4th and 5th graders focusing on using a pen pal model for integrating traditional ecological knowledge into marine science and sharing the knowledge produced across different geographical locations (Wiener & Matsumoto, 2014).

At the heart of all these projects, is an aspiration to inspire action*,* not only learning *about* something. We see this as an epistemological shift from the traditional epistemologies in learning, teaching and education developed in the Global North that all these arts education and environmental education action research projects explore and promote. The actions are not about teaching *about* waters, but instead engaging *with* waters, or maybe more precisely about facilitating learning about waters through engaging with them. In seeking to resist the binary between cognition and affect that is created in epistemologies of the Global North, the actions seek to activate learners emotionally. With the help of arts-based methods as pedagogical forces, these projects seek to open up for empathy, creativity and open-ended inquiries as well as empowerment to act, and communicate these actions through arts. The overarching aim to achieve education for sustainability is strongly present. The aim is to work with methods that give learners a feeling that they are part of nature, and which allow them to develop their own pathways of exploration (rather than a top-down teacher/student approach).

Indigenous theories and methodologies collapsing binaries

The research projects positioned within indigenous methodologies included in this review collapse the binaries that research methodologies and teaching pedagogies of the Global North rest on, such as the binary between arts and science, teacher, learner and researcher, and between land and water. They start and end with a different, holistic logic, also as research articles. Regarding the question of what arts integration means in these projects, arts and arts integration are not specifically mentioned or defined. Instead, arts and arts-based methods are part of the indigenous approach and worldview. It becomes difficult to talk about arts “integration”, as arts do not need to be integrated into a worldview and educational thinking from which they have never been separated in the first place (Malone & Moore, 2019). These projects come through as deeply arts-informed, without mentioning or defining arts specifically. One article focuses on the use of photographs with the intention of providing a means of healing for indigenous women

activists, and re-teaching ancestral values (Lane, 2018), whereas another focuses on indigenous and non-indigenous children's slow encounter with land (including waters) using arts-based methods such as images, creative writing and poetry (Malone & Moore, 2019). Also, water and land as something separated from humans collapse in these projects. Land, water and country are understood as having agency, never separated from human beings in the first place. The results of these projects are articulated in terms of healing from the colonial powers that remain disrespectful of indigenous lives and values, and as re-turning, re-learning, re-teaching, and re-vitalizing traditional knowledge and connection with place, water and land. Understanding relationships and development of a sense of place are emphasised.

Fostering ocean literacy and belonging – discussing our discoveries

Going through a long literature review process lasting several months, screening 368 research articles in a science and arts cross-disciplinary research team, reading 36 of them in-depth, and finally though a joint inclusion/exclusion process arriving at 14 studies highly relevant for this review has been a truly informative and transformative process. As an emerging research team we went through transgressive learning (Lotz-Sisitka, 2018) towards becoming environmental educators and researchers as we read, discussed, and (re-)discovered. The main insights we take with us from this literature review are that action projects working towards water education and ocean literacy through arts integration:

- are complex, messy, and deal with *wicked problems*; problems that Joyce Hwee Ling Koh et al (2015), coming from the field of design thinking in education, define as problems that cannot fully be comprehended and thereby not fully resolved.
- promote and develop critical thinking, challenging traditional, top-down and normalized pedagogical practices, seeking to create real change in practice and structure (Lotz-Sisitka, 2018)
- promote and develop open-ended, inquiry-based and creative pedagogies
- promote and develop creativity, empathy, collaboration and empowerment
- are local, place-based, connect communities as well as give back to communities, at the same time as they strive towards large and urgent issues of sustainable, just and democratic living on a global level

- are about re-turning and re-connecting to human/other-than-human, nature/culture, cognition/emotion, teacher/learner/researcher and arts/science inseparability already offered by indigenous methodologies, *extending* dominating (more than discovering new) epistemologies to collapse such binaries.

The educational action research projects presented in the 14 articles that we analysed in-depth act as connecting forces in local communities, and they involve different stakeholders across higher education, formal education and informal education. The studies are place-based and local, but work for the bigger, glocal issues that affect us all. The research teams behind these projects work collaboratively in democratic ways as they develop open-ended, arts-based pedagogies to encourage learners to act. The studies show how arts and arts education help in giving environmental education, where science education is core, the epistemological extension, or shift, needed in times of climate crises. Through this literature review, we have discovered the field of environmental education as a field changing and challenging the field of teaching, learning and education.

If there is anything we miss in the studies that we have reviewed, it is the connection to water education that seeks to develop ocean literacy for *life below water specifically*. The studies seem to develop water education more generally. In our understanding, the reason for this might be that as action research projects they are all local and place-based and seek to awaken human awareness of the water issues local learners easily can relate to. As humans do not live under water, and not in oceans, but *at* oceans, this underwater world might be difficult for us as humans to relate to. A task for us as an emerging interdisciplinary research group might be to even more clearly open up that oceanic and below water world. Doing so, we might develop the eco-systemic, ecomorphistic understanding that we are inseparably entangled with oceans. We are oceans, living in a more-than-human world.

> *Kelp plays more or less similar role as phytoplankton. Kelp is visible for us, it is close to our domain, and it can also convert CO2 and produce oxygen. The main difference of the kelp is, due to its size, that it creates sub sea forests, which are excellent habitats for many other life forms. Kelp also contributes to the conversion of CO2 into organic carbon. This organic carbon which was produced by phytoplankton is essential food for bacteria. Then some portion of it is converted back to CO2 by bacterial*

> *decomposition and another portion is converted to another type of organic carbon which is not easily digestible for bacterial consumption. That is this type of tough organic carbon that behave as nature's bank account. They can stay thousand and 10 thousand years in the deep ocean without turning into CO2 – which is a fortune for us.*

Having read and analyzed in-depth the 14 studies included in our review, we have come to wonder whether the definition of oceans literacy is inclusive of all the dimensions needed, also of those that environmental and arts education combined might contribute. As we think about how we might want to design a future imaginary action research project in dialogue with the discoveries we have made in this review, we suggest an expansion of the definition of ocean literacy by the Oceanographic Commission as indicated in blue:

An ocean literate person

- understands the essential principles and fundamental concepts about the ocean;
- can communicate about the ocean in a meaningful way; and,
- is able to make informed and responsible decisions regarding the ocean and its resources. (Intergovernmental Oceanographic Commission, n.d., unpaginated).
- experiences an emotional connection and belonging to ocean;
- has a willingness and readiness to act to protect the oceans.



Figure 4. On the shorelines of kelp forested seas, such as the Atlantic Ocean by the Western Cape coasts of South Africa, you can find kelp branches washed up. Kelp can also be seen bobbing on the surface of the sea because even though kelp forests are largely underwater, this algae seaweed (heterokont) also needs to be close to sunlight. (Design: Manola Gayatri Kumarswamy)

About the authors

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