Art-based research methods in science education research: A systematic review of their prevalence and an analysis of their potentials in addressing complex questions

Abstract
In this paper, we explore the potentials of applying art-based research methods in science education research. Art-based methods are a range of qualitative methods that draw on performative, creative, and visual elements and thus propose innovative ways to produce knowledge in research. The paper is based on a systematic review of the literature on applying art as research methods in science education research. The review shows that only a few studies within science education use art-based methods as a methodological approach. Additionally, the literature identified through a snowball approach was systematically analysed. Four themes were identified: knowledge made available through artefacts, non-verbal language, more balanced power and positions, and time to reflect. The analysis outlines the strengths embedded within applying art-based methods and the potentials that they present to science education research. The implications for research and limitations of art-based methods are discussed.

INTRODUCTION
Science education research is by nature cross-disciplinary in that it draws on epistemologies from both science and education. Thus, different epistemologies influence science education research
Duschl, 2008; Kelly et al., 2012). It was during what has been labelled the cultural turn in the early 1980s that the idea of the science researcher engaging in objective, norm- and value-neutral science was first contested (Tobin, 2015).

Inspired by the social sciences and humanities, qualitative methodological methods eventually gained a more established position within science education (Devetak et al., 2010), and today they include various methods, for example semi-structured interviews (Ulriksen & Nejrup, 2021), timeline interviews (Malm, 2021), longitudinal interviews (Holmegaard, 2020), and so-called ‘think-aloud’ interviews (Bowen, 1994). With a growing interest in social life across different cultural contexts, anthropological approaches, like critical ethnographic fieldwork (Calabrese Barton, 2001) and comparative ethnography (Carlone et al., 2011), eventually gained ground. Recently, qualitative studies have proved to be valuable in examining the complex interplay of power, knowledge, and participation on the one hand and the meeting with science disciplines and cultures on the other (Avraamidou, 2019; Gonsalves, 2020). For example, studies using science identities as a theoretical lens have explored how different forms of participation are available, celebrated, and supported as well as excluded, ignored, or alienated across different science contexts (for example: Calabrese Barton, 1998; Carlone, 2004; Due, 2014; Godec, 2017; Ryder et al., 2015).

Methods are not a neutral instrument, but they allow for certain forms of knowledge production (Denzin, 2012). Thus, to approach challenges related, for example, to social justice, it becomes crucial to investigate methods that do not limit themselves to reproducing hegemonic discourses but find new ways to unbox new insights. By following this thread of thinking, we will argue that novel and alternative qualitative methods can enable a nuanced and comprehensive understanding of such complex research challenges to be unpacked. This is our starting point in this paper.

Methods drawing on art have found their way into research areas such as anthropology (Worth & Adair, 1972), psychology (Vick, 2003), health research (Fraser & Al Sayah, 2011), and education (Prosser, 2007). In these areas, techniques drawing on art are used as a tool in qualitative methods and often support existing methods, such as interviews.

Therefore, our aim in this paper is twofold. Firstly, we offer a systematic review of the extent to which art-based research methods have gained ground within science education research. Secondly, we aim to analyse the kind of knowledge that is produced by applying art-based research methods and thus the potentials of these methods for science education research. The scope of the paper is to expand the ways in which future science education research engages in complex socio-political challenges, such as equity, diversity, and social justice (Rodriguez & Morrison, 2019).

ART-BASED RESEARCH METHODS
Art-based methods cover almost 30 different approaches (Leavy, 2017), and, given the expanding field of applying art in research, there might be even more (Knowles & Cole, 2008). Proposing one single unified definition that embraces these artistic techniques is not easy as they originate from different academic fields, in which they have been used for different purposes. However, all the research approaches that have art at their centre use art as a way to engage participants and thus enable research to produce knowledge in new ways. Therefore, in this paper, we will apply art-based research methods as an overall concept for creative, visual, and performative methods that encompass methods such as drawing (Bagnoli, 2009), using Lego (Gauntlett & Holzwarth, 2006), and making stories or poems (Eshun & Madge, 2012). It is beyond of the scope of this paper to introduce each one of these methods (for an overview see Knowles & Cole, 2008), though, to give the reader an idea of art-based methods, two short examples are provided.

Danielsson and Berge’s (2020) research is an example of a study based on video diaries. Here, the research participants record themselves and are offered a freer space in which to share their narratives. The method allows participants to take on more ownership in sharing an unprompted, reflective
monologue by controlling elements such as time, place, and subject. It replaces question and answer dialogue, which many interview methods involve, but it requires the participants to be able to express themselves in monologue format.

Another example is the use of music as a method to investigate the everyday lives of young people in their transition to adulthood. Here, young people are invited to bring with them to the interview a piece of music that they associate with a significant event or experience. Using music offers a space where strong emotions and memories are shared and worked as a way to link past, present, and future in the young people’s narratives (Ravn & Østergaard, 2018).

METHODS
To investigate the extent to which art-based methods have gained ground within science education research, we 1) conducted a systematic literature review, which is presented in the first part of the results section; and 2) undertook an additional analysis of key pieces of literature on art-based methods, not only within science education research but more generally. These pieces were identified through a snowball approach (Lindvig & Ulriksen, 2019). The analysis is presented in the second part of the results section. The focus in the analysis was on exploring the unexploited potentials for applying art-based methods in science education research.

This paper has a clear focus on research methods. As a consequence, pieces of literature that apply art in science practices, for example science teaching, to enhance student learning are left out as they differ in the aim and purpose of producing knowledge entailed in research.

A systematic literature review
To conduct the review, we used the databases Web of Science and SCOPUS to search for peer-reviewed, international publications in the area of science education and science education research that used creative, visual, and performative techniques to produce data. We based the search on the following keywords: science education research and art-based methods* OR visual* OR creative* OR performative*. We used these terms because they occur frequently in the key literature identified through the snowball approach (see below). We searched the period between 2000 and 2021 and selected only studies in English.

The search in Web of Science resulted in 39 articles, and the search in SCOPUS revealed 83 articles. In SCOPUS, the term ‘art-based methods’ was not a possible keyword. As a result, we decided to separate art-based methods into methods and art. In total, 122 publications were identified by the search. All of these were read to ensure that they met the following two criteria: 1) entailing art-based methods; and 2) applied as a research method.

The publications that did not meet the criteria were omitted. The excluded articles were all pieces in which the keywords occurred but in which art was not used with a methodological purpose in the research.

The snowball approach
To explore unused potentials for science education research embedded in art-based methods, an additional review was undertaken, namely the snowball approach. The first step in the snowball approach was to identify key pieces of literature. Here, the paper by Bagnoli (2009) and the handbook by Knowles and Cole (2008) were identified as they have both been well cited by studies using creative qualitative methods drawing on arts and thus have gained an inevitable position. The second step was to identify relevant studies in the two pieces’ reference lists in which researchers applied art-based research methods as part of their methodological approach. The third step involved reviewing the articles to understand how art-based research methods were used. To systematize the review, we performed a thematic analysis of all the materials that we found (Clarke et al., 2015), with a focus...
on the potentials that these methods offer. As a result, four themes appeared: 1) the use of artefacts as a medium between the researcher and the participants; 2) how the use of art-based methods allows for non-verbal language; 3) contests of the mechanism of power between the researcher and the participants; and 4) how the use of these methods increases the time for reflection. In the results section, each theme is presented, and the potentials embedded in art-based methods, as well as the advantages of implementing them in science education research, are investigated.

RESULTS
This section is divided into two parts. We present first the results of the systematic literature review and then the results of the thematic analysis based on the snowball approach.

The systematic literature review
Of the 83 publications found in SCOPUS, two appeared twice, and five of the 39 articles found in Web of Science had already shown up in SCOPUS. That left us with 116 publications identified through the two searches. All the papers were read to ensure that they met the two criteria of drawing on art-based research methods and applying the methods within science education research.

A group of publications did not draw on art-based research methods. In particular, the use of ‘science education research’ as a search term resulted in publications focusing on teaching in respect of tools or skills with which to improve teachers’ teaching or students’ opportunities to learn or teach. However, as the focus in this paper was on investigating the application of art-based methods within research, studies using art-based methods in science practices were not included in this review.

Another group of publications was identified through the keywords ‘creative’, ‘visual’, and ‘performative’, though without any of them being related to a particular methodological research approach. Examples cover making representations to enhance students’ skills in visualizing different subjects (Moore & Waters, 2002), the keyword performative resulted in papers on how people perform in different situations (Clement, 2004), and the word ‘visual’ produced papers on visualizing and visual representations, for example to enhance students’ skills in visualizing different subjects (Moore & Waters, 2002).

Of the 122 publications identified from the two databases, only three contained empirical data produced from what we have defined as art-based research methods. Below, a short description of the three publications is provided.

Neumann (2014) explored students’ associations, emotions, and risk perceptions of radiation using drawings, interviews, and a ‘trend study’ (a statistical technique to identify overlaps between future behaviours by understanding past ones) before and after the tragic events in Fukushima in 2011. The study showed that learning about radiation was mostly associated with negative emotions. To support more nuanced learning, the research group suggested that science teachers must scaffold learning to include the positive aspects of nuclear power.

Akın and Uzuntiryaki-Kondakci (2018) focused on novice and experienced chemistry teachers when teaching about reaction rates and chemical equilibrium topics to understand interactions among the components of pedagogical content knowledge (PCK). Akın adopted a qualitative multiple-case design study utilizing methods as a card-sorting activity, a Content Representation (CoRe) tool, semi-structured interviews, observation of instruction, and field notes. The card-sorting activity was carried out before an instruction to elicit the teachers’ purpose and goals of teaching chemistry. Akın designed 12 cards describing different scenarios related to chemistry teaching. The teachers were asked to sort the cards into three categories (representative, not representative, and unsure) and to explain how these scenarios related to their own chemistry teaching. This activity helped to provide an understanding of the difference between what teachers think about their teaching and how they teach.
Fachrunnisa and colleagues (2020) examined the reinforcement of creativity as a learning skill to meet and overcome future challenges in society. The qualitative study explored 25 pre-service biology teachers’ reflections on their own creativity and the use of creativity in teaching biology. The student teachers participated in a model strategy, teaching the visible thinking approach integrated with the biology context within three learning cycles. Using a reflective essay instrument allowed the participants to reflect on their experience and encouragement with four indicators of creativity (fluency, flexibility, elaboration, and originality). The results of the project showed that the participants’ reflections centred on emersion, misunderstanding, and refraining ideas when reflecting on creative thinking skills and processes. Based on this knowledge, the project developed a three-step strategy that can be used to work with creativity in biology.

The systematic literature review showed that, despite qualitative methods being widely applied in science education research, art-based research methods have not yet gained ground. However, while art-based methods have rarely been used in science education research, creative approaches in schools are far from being a new phenomenon. Science teachers use creative tools in their classes to make space for different learning processes. Here, visualizing teaching materials offer a range of benefits to support teaching in science classes (Pederen, 2018). With qualitative methods being widely applied in science education research and art-based activities being used in science teaching, we will show in this paper that there is an unexploited potential for bringing art-based research methods into science education research. Therefore, this paper focuses solely on the potential for using art-based methods in science education research to support qualitative methods.

THE POTENTIAL FOR APPLYING ART-BASED RESEARCH METHODS IN SCIENCE EDUCATION RESEARCH

Based on the key studies identified through the snowball approach, in this section, we present a thematic analysis of the knowledge potential produced by applying art-based methods. Firstly, the analysis investigates how art-based research methods allow for other forms of communication. Secondly, the use of artefacts opens up new forms of expression and participant engagement in research. Thirdly, we explore how art-based methods negotiate the mechanisms of power between the researcher and the participants. Finally, we consider how these methods create more time for reflection in the meeting between the researcher and the participants. The limitations of art-based methods are discussed at the end of the section. The section is organized in respect of these four overarching themes, which we label: 1) non-verbal language, 2) power and positions, 3) knowledge through artefacts, and 4) time for reflections. Although the four themes overlap, we deal with them separately so that a deeper analysis of their respective strengths can be undertaken.

Non-verbal language

Most methods, such as interviews, observations, and surveys, rely on oral or written language and on the ability to narrate situations and experiences. This, for example, is the case of qualitative interviews. In observations, the focus is on actions and accounts as they unfold in everyday contexts, in which, again, the use of written language in field notes plays a significant role (Hammersley & Atkinson, 2007). However, oral and written accounts are only some of various ways in which the participants involved in empirical work can express themselves as expressions draw on a repertoire of and interplay between various sensory relations, such as colours, sounds, smells, and shapes. Using art-based methods, the researcher can engage and activate a broader spectrum of expressions, gaining novel insights into how the world is presented to the research participants (McNiff, 2008). One example is the use of collage as a way of understanding ethnic identities among young people from different backgrounds based on how they see themselves and how they think others see them (Awan, 2007). Using this method, the participants are given a blank surface, often a sheet of paper and various materials in the forms of newspapers, photos, or other sources often connected to a theme. The idea is to let the participants place the materials on the surface in ways that define or link them or
remind the participants of the theme. The participants choose what to add to the collage and where to place it depending on the story that they want to tell. This involvement is based on emotions and feelings and how the pictures, images, and other sources elicit emotions and feelings about how the participants interpret and perceive them. It is a process that has the strength to elicit meanings that might be hard to verbalize because of social norms (Marcu, 2015). It provides the participants with the opportunity to construct their own interpretations of the research aim. They select which pictures to use in creating the collage, and it is their interpretations of the pictures and what the pictures evoke in them that matter.

It is worth paying attention to these various elements that extend beyond oral and written language because they challenge the barriers and constraints related to language skills, such as cognitive abilities and native language (Polkinghorne, 2005). The vulnerability of language requires the abilities to recognize, remember, and pronounce with confidence when speaking and writing (Brooks et al., 2020). Such challenges are overcome by utilizing the potential of art-based methods to move beyond language skills and barriers by expressing wordless understandings of the world.

When applying art-based methods, other forms of expression, narratives, and perspectives are allowed that make language less central (Dodman, 2003). This, however, does not mean that language is irrelevant as many art-based methods act as a platform for creating a dialogue between the researcher and the participants. However, instead of setting the scene for the empirical production, language acts as a support in explaining the artefact, for example a drawing or a photo.

Moreover, art-based methods have the potential to access what is described as wordless knowledge (Patton, 2020). Wordless knowledge emphasizes a more tacit knowledge embedded in the body and as a consequence challenges the idea of knowledge as something that can be reduced to rationality and language (Eisner, 2008). The consequence of approaching knowledge as something exceeding words and numbers thus calls for novel and innovative ways of generating new knowledge (Chaplin, 1994). As Eisner stated: ‘knowing is a multiple state of affairs, not a singular one’ (Eisner, 2008, p. 5).

This supports the argument that different methods are suitable for producing different forms of knowledge both to understand various research questions and to engage a diversity of research participants. Art-based methods allow for expressions that exceed oral and written language, and, as a result, such methods present the potential for destabilizing the categories produced through language that have become natural and instead allow for new and critical ways of thinking. An example is a study in which artwork made by students investigated how oppressive conditions became familiar within education in postcolonial Hawaii (Kaomea, 2003). Another such example is the study by Nielsen, who explored drawings produced by girls and boys. These drawings were used as a platform for investigating the cultural differences between the ways in which boys and girls expressed themselves (Nielsen, 1996). These examples of making everyday perceptions understandable highlight the importance of allowing space for novel methods that support creative expression.

Such creative methods have the advantage that they enable abstract notions to enter into sounds, drawings, pictures, or movements, where they may unlock different understandings of a phenomenon (Bruselius-Jensen & Danielsen, 2018; Pless & Katznelson, 2018). Bruselius and Danielsen explained that they concern not exclusively what is shared but also how it is shared: the pauses, the rhythm, and the tone indicate how the participants prefer to represent themselves (Bruselius-Jensen & Danielsen, 2018). This approach offers another way of encountering research.

Inviting participants to use artefacts bridges the gap between language and experience with other forms of communication based on embodied presentational forms. The performance of bodily expressions when interacting with environments such as other persons or materials is not always expressed in words but sometimes articulated through other senses, which can be expressed through art-based methods. This provides an alternative for understanding how participants respond to their social worlds in a more physical and personal form. Working with art provides a space in which to
connect with memories and perceptions and to evoke our emotions and capacity to feel; as Eisner pointed out, art helps us to ‘discover our own interior landscape’ (Eisner, 2008, p. 11).

By reducing our use of spoken words, we might liberate new opportunities to share narratives that may have been overlooked in the preference for language. Using art-based methods enables participants to express themselves through these non-verbal forms, presuming another kind of participation by them. An artefact is not only an object in the world; it also mediates the dialectical relationship between external and internal interpretations of our senses. By reducing the interruption of oral and written language, an approach like drawing a self-portrait offers participants the lenses through which to see their lives differently (Bagnoli, 2009). This became visible in a study on children’s understanding of health in their lives (Wetton & McWhirter, 1998). Children were provided with a picture of a figure with smiling white teeth, but, based on a presentation of mouth hygiene, they drew figures with black and sharp teeth. This depiction illustrated a mixture of playfulness, ideas, and interpretation created by the possibilities of drawing. Instead of asking children about the health effects of sugar, the participants were allowed to communicate using non-verbal skills. Conversely, language needs a meaningful connection with the spoken word; contents of drawings are detached from these linguistic practices. Drawings overcome the limitations of language by moving between the known and the unknown. Nielsen, in her work with students, showed how the visualization of abstract topics, such as the future, is made more accessible through drawings. Depicting their future allows students to discuss different future selves (Nielsen, 2021).

This distinctive opportunity provided by drawing creates a space for participants to obtain ownership because the artefact becomes visible and physical in a different way from spoken words. The researchers hand over the task for the participants to complete without defining or determining how the artefact is produced or dictating the process. Dictation means the designing process whereby the participant draws the drawing. Moving beyond language, there is an unexplored potential to encounter the research field and to meet one’s participants under conditions that frame a less power-laden relationship and that allow access to the obvious and unnoticed in everyday life.

Knowledge accessed through artefacts
The main point of art-based methods is the use of artefacts, that is, objects placed between the researcher and the participants. Artefacts can be anything from Lego designs to drawings or music. As a medium, the artefact invites both the researcher and the participant to adopt other perspectives and positions. The artefact may trigger forgotten memories and access other layers of consciousness (Harper, 2002). It allows different and new insights to be accessed through a bodily interaction with the artefact involving holding, seeing, and creating, which the authors argued ‘leads to a deeper and more reflective engagement’ (Gauntlett & Holzwarth, 2006, p. 89).

Using artefacts is a way to activate memories through something concrete. Materials and objects surround us in the world, and they are often embedded with certain meanings or, as Skeggs stated, ‘certain tastes’ (Skeggs, 2004). These meanings might be difficult to research through language, and they may have acquired a simplified understanding that is less recognizable. The use of artefacts opens a new entry point to understanding these meanings or tastes. Examples of using drawings as an entry point to understand how certain stereotypes become institutionalized give knowledge to the consciousness that forms our minds and being in the world.

We can see this in the ‘draw-a-scientist’ test by (Chambers, 1983). Chambers provided a very powerful idea of what stereotypical images of a scientist involve and what they exclude. Moreover, a study like this shows how powerful stereotypical images can be and how static they are, yet they develop over time. When working with artefacts, in this case drawings, the researcher obtains access to this world of details, through which the visibility of the symbols is displayed. The drawings show how symbols are so cultivated in respect of certain stereotypes that they become natural to our perceptions of the world. This, moreover, highlights how our interacting with our surroundings is based on images, which can be achieved by utilizing art-based methods.
However, it is not only the artefact itself that is interesting but also the processes through which the artefact is produced, what is represented, and which different needs and styles this involves (Bagnoli, 2009). The artefact becomes a transfer for understanding participants’ visual preferences and how they interact with their choices and the framing and considerations that they make when creating the artefact (Warren, 2005). Creating an artefact or a performance has the potential to move the participants and the researcher away from their everyday behaviour to indulge in a deeper reflection on the process that creates the product. It is not only about the product and the process of designing the artefact, like deciding what to take pictures of and what to erase from or add to a drawing. What one suddenly remembers draws more attention to the creation and how the participants may wish to represent themselves.

At the same time, the artefact has the strength of defamiliarization (Shklovsky, 1917), a concept created in the field of art, which is a way of slowing down our perceptions to recognize what has become stale in our everyday lives (Mannay, 2015). In this case, the defamiliarization is the artefact requiring the participant and researcher to slow down (Mannay, 2010), allowing them to acquire new perspectives and different views. As a result, it can be the unseen or forgotten elements of the everyday life lived by the participants that are made visible (Pless & Katznelson, 2018). In other cases, the artefact might act as a go-between for material in which sensitive topics are more easily expressed because the participant may feel less pressured (Heath et al., 2009; Prosser & Loxley, 2008). The strengths of these methods often lead to their use with vulnerable groups, such as the homeless (Packard, 2008) or the sick (Fraser & Al Sayah, 2011; Frith & Harcourt, 2007; Frost & Smith, 2003). However, these methods have also provided a whole new entry point in studies in which children and young people participate in research because they allow creativity to be used as a way of telling.

Moreover, by including such artefacts in research, the researcher gains access to meanings and interpretations though other materials, objects, and sensory support. These methods provide access to bodily knowledge, understanding the body as being a central aspect of individuals’ emotions, opinions, intelligence, and experience (Merleau-Ponty, 1982). Thus, placing artefacts at the centre of the investigation is a way of enabling new ways of sharing narratives and experiences to emerge. Inviting an artefact into the research field emphasizes and reinforces the power of non-linguistic elements to count as legitimate ways of expressing and interpreting. This engagement opens up a new form of narrating something because the narratives are transformed into other forms, such as drawings and collages, clay models, poems, and so on. Everything from seeing and feeling to performing may emerge from the artefact, generating new questions, connections, and meanings. This promotes other ways of sharing narratives. When we consider our senses as something legitimate with which to interpret our world, we gain a more diverse spectrum of knowledge on how to encounter science.

**Power and positions**

This theme examines the possibilities that art-based methods offer to disrupt power relations when producing qualitative empirical material. The mechanism of power is related to the positions that we encounter as both researchers and participants and the way in which these positions interact with and exert an impact on research.

Art-based methods offer a shared space where control over what is undertaken and how is negotiated by the participants (Awan & Gauntlett, 2011; Mannay, 2015). The researcher is the one who leads and controls the pace of the interaction, while the participants are those whose responses are challenged. However, it becomes possible to open up other forms of conversations that are characterized less by a one-way dialogue. This also acts as a critique of qualitative interviews that are dominated by asymmetric power relations, with the researcher often being in control (Kvale, 2002). By using art-based methods, such asymmetric power relations are redefined because the power moves between the two parties. Adriansen showed how timeline interviews can provide a platform for sharing what she labelled ‘analytical power’, which enables a position from which key experiences and events are selected and presented by the participant (Adriansen, 2012). Thus, involving an artefact has an impact on the way in which power is shared because the production of an artefact creates a new position from which participants can produce and communicate knowledge relating to them in new ways.
One example of what such a shared space can look like and how the participants can engage in the production of data is provided by studies in which the latter are encouraged to select or take their own photos (Hubbard, 1994). This, for example, is the case of the research by Staunæs (2004), who studied race, ethnicity, and gender in relation to school life in a seventh-grade class and, among other methods, used snapshots as a way of eliciting the participants’ perceptions of their school lives. Another example is Rasmussen (1999) work with children aged eight to 12, aiming to understand the possibilities of using cameras to obtain insights into children’s lives outside school. In both studies, the participants were asked to take pictures of their everyday lives and were encouraged to talk about them. When meeting the researcher, they were invited to describe how they had composed the photos and what they aimed to capture by taking them. The photos were thus used as a platform for gaining a more detailed and concrete understanding of the young people’s lives from their own perspective as a way to uncover the unknown (Packard, 2008). This invites one to acquire an awareness of places, things, or objects that might seem irrelevant but are significant to the participant. By means of the researcher sharing analytic power with the participants, the latter are provided with a position from which they can share their points of view and decide what is important to them and what matters in their current situation. The aim is to generate a more balanced relationship in which the construction of interpretations becomes a shared activity for both the researcher and the participant. As Rasmussen (1999) stated, there is the physical experience (how the world is seen from a height of 1.30 cm) and the mental experience (how a 12-year-old person meets the social world). This shows the opportunities that give the participants greater control over producing data, which is less controlled by the researcher.

In conclusion, by using art-based methods, such as a camera, possibilities are opened up to achieve a position in which the participants become an “expert” on their own worlds’ (Leitch, 2008). Regardless of the choice of art-based methods, the participant maintains a position in which negotiating control over the act of creating is possible. This increases the level of engagement and establishes a more equal relationship between the two parties (Prosser & Loxley, 2008).

By giving more control to the participants, we create a space in which they can enjoy more control. We see this in action research as well – the idea of creating a temporal free space, or at least a freer space, is sought (Thingstrup, 2015). In both approaches, the aim is to provide a platform for the participants to interpret and solve the research task for a while, without interruption by the researcher.

Gaining more time for reflection

When working with art-based methods, it becomes significant to consider the dimension of time: time to reflect, time to engage with the artefact, and time to embrace a slower pace. Often, when we talk, we respond immediately because it is polite but also because silence in a conversation is experienced as discomforting (Newman, 1982). Talking is a flow of exchanges, a way of responding verbally and non-verbally to others, which makes the conditions for reflexivity less favourable. Art-based methods allow for a different type of interaction, creating a space that allows time for reflection. When working with an artefact, participants need time to create or build what is in their mind, which prompts slowness (Gauntlett & Holzwarth, 2006). Stories told with artefacts need time for the participants to reflect on the task, transforming the reflective process by moving it from an internal to an external process (Gauntlett & Holzwarth, 2006; Ingram, 2011). The experience of reflecting is present when creating something. The participant needs to imagine the artefact and then create it. This entails a double reflexivity that is bound to both process and product and is both physical and sensible to the participant as well as the researcher (Rasmussen, 1999). Depending on which art-based method is being used, the understanding of slowness has the power to extend the time spent on research. The researcher can, for example, provide the participants with an opportunity to create without the researcher’s presence (Mannay, 2010), which extends time because it is not located in a single concrete situation.

Of course, other ways of using art-based methods are temporal, but that does not change the space for reflexivity. The reflexivity that emerges from the artefact used by the participants responds and establishes a new dimension.
DISCUSSION AND CONCLUDING REMARKS

Methods are not neutral but offer researchers a certain set of lenses through which to approach the world. For science education research to unpack and approach novel and complex socio-political challenges, such as equity, diversity, and social justice, and to exceed the reproduction of existing power and knowledge structures, in this paper, we argue that it is crucial to develop and apply new qualitative methods to support alternative, nuanced, and comprehensive forms of knowledge.

Art-based qualitative methods have gained ground in related research areas, such as education, in which they have proven to be vital in gaining insights that more widespread methods, such as surveys and interviews, struggle to capture (Brooks et al., 2020). Based on a systematic literature review, we showed how art-based research methods have gained limited ground within science education research with a few identified studies. The scope of the paper was to investigate the kind of knowledge that is produced by applying art-based research methods and thus the unexploited potential that these methods offer science education.

As shown, art-based methods come from different research fields based on different epistemologies depending on their methodological approach and theoretical grounding. As such, it is not in the scope of this paper to generalize art-based methods as one homogeneous research paradigm set by a certain epistemology but rather to seek how these various methods might support and provide space for new forms of knowledge to emerge in science education research. Based on studies applying art-based methods identified through a snowball approach, we carried out a thematic analysis. As a result, four themes were identified: knowledge through artefacts, language, power and positions, and time to reflect.

We showed how working with artefacts encourages new ways of meeting participants by providing a space in which to share experiences by moving the attention from the participants to the artefact. This reveals new insights into how participants interpret the world and allows for a greater level of engagement because linguistic skills and language are less of a barrier. However, there needs to be awareness of the participants’ prerequisites for and experiences with engaging in art-based methods. We suggest that researchers applying art-based methods pay particular attention to the participants’ creative abilities and preferences. These include practical experiences when forming, drawing, listening to, or picturing that provide some participants with the ability to engage in and interpret art-based methods because they have been exposed to art in their lives, while other participants may feel more alienated. When analysing the artefacts applied in and produced through the data, it is thus crucial not only to include the product itself but also to analyse its creation.

In the paper, we showed how oral and written accounts are only some ways in which participants involved in empirical work can express themselves. Art-based methods offer a platform for moving beyond the limitations embedded in language, such as cognitive and linguistic abilities, as well as the ability to recognize, remember, and formulate oneself. Moreover, art-based methods can engage participants with speaking and writing disabilities, and the methods are particularly relevant for children, who lack huge language repertoires. Furthermore, art-based methods have the potential to engage groups that might not be used to finding words for experiences that are not commonly recognized or shared, as is the case with marginalized groups in STEM (Siry & Gorges, 2020). However, a relevant objection here concerns whether art-based methods actually extend beyond language. For example, Laclau and Mouffe (1987) argued that linguistic and non-linguistic elements alike establish meaning through discourse and therefore all objects are socially constructed, being articulated in different positions in which they acquire meaning. This highlights the understanding that we access the world through language and therefore never escape it. In this case, it is crucial to pay attention to how the participants construct the art-based objects and how they make meaning out of them but more importantly how the researcher understands art-based objects. Here, the transparency of the analytical approach becomes vital for the reader in following the steps taken in interpreting the participants’ engagement in the methods and the artefacts that they are presented with and produce. The analytic approach to art-based methods has not been the scope of this paper, yet we believe a fruitful next step could be to discuss how art is analysed or not through language.
The analysis showed how time to reflect becomes key when working with art-based methods. In interactions with research participants, there is a flow of non-verbal and verbal recognition, prompts, and responses that seems natural; as a consequence, long breaks are considered impolite. Art-based methods, by contrast, create the space and time for reflection. However, it could be contested whether more time provides better or more authentic insights into the research question. Our point is not that more time to reflect produces a truer version of the analysis. Instead, we argue that time to reflect is often lacking in tight and compact methods in which carefully planned themes or questions provide limited room for participants to construct their own narratives.

In the analysis, we showed how art-based methods support and contribute to challenging power, imbalances, and inequalities by enabling positions in which the participants have more influence on the production of data. Even though art-based methods address these unequal relations between the researcher and the participants in new ways, they do not fully escape these unequal positions. While they unlock new forms of entering and understanding these positions and thus reduce the inequalities in the methodological process, art-based researchers must still be attentive to asymmetric power relations when producing and analysing data and when choosing which art-based methods to use.

A final concern regarding art-based methods is the extent to which there is a discrepancy in putting such methods forward to science teachers, science students, or scientists. We have shown how these methods can be applied to a range of different research aims and participants as well as demonstrating the potential that these methods bring to science education research. However, we suggest that science education researchers start cautiously in selecting activities such as using photos and drawings that might be familiar to the participants. Introducing methods that are outside the comfort zone will emphasize that the researchers guarantee to create a safe and inclusive space where it is clear to the participants what their roles are expected to be (Feuerstein, 1988). It is our experience that this does not apply only to art-based methods.

In conclusion, we have shown that innovative art-based research methods can unlock new insights into science education research and that they have great potential for expanding the already-established repertoire of qualitative methods.

REFERENCES


Art-based research methods in science education research


Mannay, D. (2010). Making the familiar strange: Can visual research methods render the familiar setting more perceptible? *Qualitative research, 10*(1), 91-111.


