The Scope and Status of Sustainability Education in Out-of-School Settings across Denmark

Abstract

Denmark has a strong foundation in terms of sustainability, making the country an interesting backdrop for studying how the overarching sustainability agenda has shaped education practice. This study investigated the scope and status of sustainability education targeted at grade 4-6 students in Danish out-of-school science education institutions, such as natural history museums, science and technology museums, science centres, zoos and aquaria. First, a desktop review took place to map educational programmes with sustainability content. Second, five representative programmes were selected for further study. Thematic analysis of observation field notes and interviews with educators and teachers yielded four themes that collectively defined the sustainability programmes: institution, formal education, content and pedagogy. The final sections of the paper contextualise these themes, and discuss their implications for sustainability education in out-of-school practice. The study concludes by offering reflections on constructive future pathways for sustainability education.

INTRODUCTION

Denmark has a strong foundation in terms of sustainability. The 2020 Sustainable Development Report, measuring nations’ progress towards the Sustainable Development Goals (SDGs), ranks Denmark in second place out of 166 countries (Sachs et al., 2020). The country is a global leader in wind power (Wang et al., 2017) and well known for having a social welfare system supported by high taxation (Breiting & Wickenberg, 2010). Important Danish societal characteristics include a focus on collective rather than individual interests, as well as the ‘preservation of the public good’ (Wals, 2010, p. 147). In 2009, the capital city of Copenhagen hosted the annual climate change summit (COP 15) (Breiting & Wickenberg, 2010) and is attempting to become the world’s first carbon neutral city by 2025 (Birnbaum, 2019). Copenhill, a waste to energy power plant providing energy for tens of thousands of people, doubles as a recreational site all year round through a café, ski-slope and hiking trails (Nordestgaard & Arndt, 2019). Recent extreme weather events in Denmark, such as the abnormally...
hot summer of 2018, have shifted political, business and citizen focus further towards sustainability. Awareness and concern is growing among the younger generation of eco-citizens (cf. Heggen et al., 2019) and youth climate strikes have received large attendances across the country. In 1993, the Danish government encouraged all schools to add in environmental issues to their curricula (Mogensen & Nielsen, 2001). Today, sustainability forms a part of the Danish school curriculum in many subjects, including the sciences, technology, social studies, history, geography, food literacy and fine art (Simovska & Prøsch, 2016).

Denmark’s positive strides towards a sustainable future make the country an interesting backdrop for studying how the overarching sustainability agenda has shaped education practice. The Danish government created an Action Plan for the SDGs in 2017 (Danish Government, 2017), which acknowledges the important role of stakeholders and civil societal actors in moving towards a sustainable future. Denmark’s range of out-of-school opportunities form an important component of this Plan. However, the 2020 Sustainable Development Report labels goal 4, Quality Education, as stagnating in Denmark, while all other SDGs are progressing. This result is due to a decrease in the underachievers and resilience of students in science (Sachs et al., 2020). In addition, Danish sustainability education has fallen behind Sweden, due to greater focus on enhancing science education (Breiting & Wickenberg, 2010).

As indicated above, sustainability plays an important role in the formal school system in Denmark (e.g. Simovska & Prøsch, 2016). In contrast, research has identified the special potential of out-of-school science education institutions (OSSEIs), such as natural history museums, science and technology museums, science centres, zoos and aquaria, for preparing citizens for a sustainable future (e.g. Berg et al., 2021; Clayton, 2017; Evans & Achiam, 2021; Janes & Grattan, 2019; Patrick et al., 2007). These institutions offer a highly trusted, educational and experiential experience suitable for a wide-range of ages, across both political and societal spectrums (Cameron, Hodge & Salazar, 2013; Clayton, 2017). OSSEIs are located throughout all regions of Denmark and have different areas of expertise and institutional conditions. Many Danish OSSEIs offer a range of school programmes for visiting classes, with content and activities drawing on their expertise and institutional conditions. Formats range from on-site educational programmes to outreach programmes and visits to off-site locations, such as recycling centres.

The strong foundation of sustainability within Danish society, combined with a passionate and engaged younger generation and the range of out-of-school opportunities, present a robust platform for sustainability education. In turn, this may prompt a range (and depth) of initiatives, shaped by the strengths and expertise of Denmark’s OSSEIs. The aim of the study is to investigate the scope and status of sustainability education in OSSEIs across Denmark. This mapping research can play an important role in furthering understanding of the current situation of out-of-school sustainability practice in Denmark. It will highlight the challenges faced and potentially lead to an indication of (and the sharing of) best practices, and finally, indicate future areas for improvement.

**METHODS**

In this study, quantitative and qualitative methods were used to investigate the scope and status of sustainability education. The data collection took place in two main phases, first the scope (quantitative) involving a review, search for sustainability content and then selection, followed by the status (qualitative) in the form of interviews and observations (Figure 1).
Figure 1. The three stages (A-C) in mapping the scope and status of sustainability education in OSSEIs across Denmark. The first step (A.1) identified 169 school programmes targeted at grade 4-6.

A focus is placed on school programmes designed for visiting classes between the ages of 10-12 years old (grade 4-6, also known as the intermediate stage in Danish education). This age range was chosen because students aged 10 often display a positive attitude and interest towards science (i.e. Archer et al., 2010), with no distinction found between genders (Murphy & Beggs, 2005). Attitudes and interests are often fully developed by the age of 14, and motivation dramatically decreases throughout the teenage years (Archer et al., 2010).

To assess the scope, that is, the number of sustainability programmes offered, and the range of topics addressed, a quantitative review of school programmes offered by Danish OSSEIs was carried out (Figure 1). The quantitative data then formed the basis to select representative programmes. Those selected formed the basis for a more in-depth, qualitative investigation of the status, using thematic analysis (cf. Braun & Clarke, 2006).

A.1) Desktop Review
Research took place in February 2020, with a second confirming review in September updating the data set. Firstly, school programmes targeted at grade 4-6 were searched for, using information found on the institutions’ own websites. OSSEIs included were affiliated with the natural sciences and offering natural science education programmes. Programmes were included if led by an OSSEI practitioner and held on-site at the institution. Programmes targeted at a broad age-range (i.e. grade 1-10) that incorporated grades 4-6, as well as programmes targeting at least one of grade 4, 5 or 6 (i.e. grade 1-4 or just grade 6), were also included.

In the desktop review, a preliminary list of 169 school programmes across 23 OSSEIs were identified. These 23 OSSEIs represented five well-known types of OSSEIs, including natural history museums, science & technology museums, science centres, zoos and aquaria. More than two thirds (or 116 of 169) of the programmes were offered by either a zoo or aquarium (Table 1).

<table>
<thead>
<tr>
<th>Type of OSSEI</th>
<th>Number of Institutions</th>
<th>Number of School Programmes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural history museum</td>
<td>5</td>
<td>33</td>
</tr>
<tr>
<td>Science and technology museum</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Science centre</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Zoo</td>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>Aquarium</td>
<td>6</td>
<td>52</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>169</td>
</tr>
</tbody>
</table>

Table 1. The number of institutions and school programmes for each type of OSSEI targeted at grades 4-6.
As the 23 OSSEIs were categorised, occasionally it was difficult to distinguish between the five types of OSSEIs, based on their ‘traditional’ characteristics (cf. Cameron, Hodge & Salazar, 2013). On the other hand, these characteristics are important, due to the influence they have on sustainability education programmes. Data collection worked on the assumptions of natural history museums and science and technology museums being predominantly collection based, considered science centres to be focused on providing kinaesthetic, hands-on experiences (Schwan, Grajal & Lewalter, 2014), and zoos and aquaria basing their work on live biodiversity collections and conservation intentions (McCalman, 2017).

A.2) Criteria for Sustainability Content in Programmes
Using information provided on institutions’ websites, the 169 school programmes were analysed for sustainability content, and involved two criteria for inclusion. Firstly, programmes were included that explicitly described their content in terms of humanity’s impact on the planet. Secondly, this content was deemed to play a major role in the session’s focus and activities. This process led to eight OSSEIs removed from the sample, due to having no sustainability programmes targeted at grades 4-6. Many programmes were excluded immediately due to their topics having no clear or obvious links to sustainability. Examples include programmes carrying out dissections focused on anatomy, using mathematics to discuss an animal’s diet, and using artistic methods to draw biodiversity. After careful deliberation, further programmes were excluded due to having no explicit connections to sustainability. Examples of this are zoos and aquaria programmes disseminating a species’ biological traits, such as anatomy, adaptations and diet, but with no explicit connections to i.e. a changing climate, pollution, loss of habitat or poaching.

A few programmes contained sustainability content through a list of specific elements of the Danish school curriculum that the session targeted. For example, the programme Wildlife of The Winter Forest, offered by Aqua Aquarium & Animal Park, disseminates animals’ biological traits (i.e. adaptations to winter). One of the targeted curriculum elements is ‘students will have knowledge of the human impact on natural areas over time’. Without observing the programme, it could not be ascertained to what extent this particular curriculum element played a role in the session. Accordingly, the programme was excluded based on the assessment that the programme focus and activities lacked sufficiently explicit connections to sustainability.

Next, sustainability topics were identified that characterized the programmes, drawing on sustainability research literature, the 17 SDGs, and their associated targets.

A.3) Selection of Samples of Programmes
A smaller sample of sustainability programmes were selected, representing the diversity of geographical location, type of OSSEI and sustainability topic. This smaller sample formed the basis for investigating the status of sustainability education in OSSEIs across Denmark, using interviews and observations.

B) Practitioner Interviews
Five semi-structured interviews were carried out with practitioners, i.e. school programme directors or main educators, associated with the programmes selected, with one representative from each of the five types of OSSEIs. The interviews took place in English between September to December 2020. As this part of the research aimed to investigate the status of sustainability education, interview questions were targeted at providing a more detailed understanding of programme content, and how the institution’s specific subject area, pedagogy and societal role influenced the dissemination of sustainability. Freehand notes were taken throughout each interview. Due to COVID-19, only one interview could take place face-to-face, meaning three interviews were carried out by phone and one by Zoom video. The variety of different communication methods potentially had an impact on how the different interviewees responded to the questions. For example, prior to the single face-to-face meeting, the researcher and interviewee spent a whole morning together at the institution to first observe the relevant selected programme. This additional time together in comparison to the other interviews may have affected the data collected.
C.1) Observations of Programmes

Due to COVID-19, three programmes were observed, with an additional interview carried out for the two missed programmes. With this part of the research once again aimed at investigating the status of sustainability education, observations provided a more in-depth understanding of the scientific content of the programme and pedagogy used in exercises, building upon the interview data. Most importantly, observations allowed for the following of student interactions, such as how they approached a problem solving exercise and their general interest in the topics. The researcher introduced themselves at the beginning of every observation to explain why there was an additional adult present. Field notes were taken throughout each observation and the researcher carefully positioned themselves to minimise disruption to students, teachers and educators.

C.2) Teacher Interviews

Semi-structured interviews were carried out with a teacher attending the session with their school class. Four teacher interviews took place in total, with two from different classes attending the same programme on the same day, but at different times. Interview questions aimed to clarify the reasons for participating in the programme, the pre-session work carried out and the use of the experience post-session.

Data Analysis

Researcher’s field notes for the four teacher interviews and three observations were analysed using thematic analysis (cf. Braun & Clarke, 2006). Main themes were identified, using both inductive (bottom-up) and deductive approaches (top-down), using the six stages of Braun & Clarke, (2006). The first stage involved re-reading the data set to become familiarised with it. For the second stage, initial codes were created by looking across the data set, developing these codes into themes and sub-themes during the third stage. Decisions were made on sub-themes and individual codes by deciding what was foreground and background. Themes were reviewed in the fourth stage, and consequentially led to some sub-themes moved to create a more coherent analysis. The fifth stage involved the re-defining of themes, and focusing on the overall narrative. Finally, the analysis was written up, and the themes and corresponding sub-themes are presented in the following sections.

RESULTS: THE SCOPE OF SUSTAINABILITY EDUCATION

A total of 34 school programmes were identified to include sustainability content, making up approximately 20% (34 out of 169) of the reviewed programmes targeted at grade 4-6 in Danish OSSEIs. These 34 programmes were offered by 15 OSSEIs, meaning close to two-thirds (15 out of 23) of OSSEIs reviewed offering programmes containing sustainability content (Table 2). All five types of OSSEIs offer at least two programmes, with zoos and aquaria again offering over two-thirds (or 23 of 34). The 15 OSSEIs are located across Denmark, representing Zealand (eastern Denmark), Funen (central Denmark) and Jutland (western Denmark) (Figure 2).

Table 2. The number of institutions and school programmes for each type of OSSEI targeted at grades 4-6 containing sustainability content.

<table>
<thead>
<tr>
<th>Type of OSSEI</th>
<th>Number of Institutions</th>
<th>Number of School Programmes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural history museum</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Science and technology museum</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Science centre</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Zoo</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Aquarium</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>34</strong></td>
</tr>
</tbody>
</table>
Figure 2. A map of Denmark showing the locations of the 15 OSSEIs containing sustainability content and the number of programmes they offer.

Sustainability Topics

The 34 school programs address six sustainability topics. They are as follows (with associated SDG targets): biodiversity conservation (15.5), climate change (13.3), food (i.e. a sustainable diet – no SDG target), plastic pollution (SDG 14.1), the SDGs, and technology (9.4). Three outlier programmes on evolution, a lake survey and a quiz, respectively, were deemed as not fitting into any of the six above, leading to the creation of an ‘Other’ topic.

The most frequent sustainability topic was biodiversity conservation, present in over two-thirds (or 24 of 34) of school programmes, offered by natural history museums, zoos and aquaria. Climate change was the second most frequent sustainability topic, forming a part of almost one quarter (or 8 of 34) of school programmes, with all five types of OSSEIs offering programmes on this topic. Plastic pollution was the third most frequent topic, found in almost one fifth (or 6 of 34) of programmes and offered by science centres and aquaria. Technology appeared in 4 of 34 (or 12%) of programmes, offered by science and technology museums and science centres. The SDGs as a central topic of the session (rather than just briefly introduced or used in an exercise) was found in 3 of 34 (or 9%) and offered by natural history museums and zoos. Finally, food appeared in 2 of 34 (or 6%) programmes, offered by a science centre and an aquarium (Figure 3). The highest occurrence of topics appearing together is biodiversity conservation and climate change, in just under one sixth (or 6 of 34) of programmes, offered by natural history museums, zoos and aquaria.
Figure 3. The breakdown of sustainability topics in 34 school programmes targeted at grade 4-6, offered by fifteen OSSEIs across Denmark. A programme could address more than one sustainability topic.

Selection of Programmes
Programmes selected for qualitative analysis represent the five types of OSSEIs, the five most frequent sustainability topics (biodiversity conservation, climate change, plastic pollution, the SDGs and technology) and a geographical spread across Denmark. In addition, the selected programmes have a range of target age-ranges and session lengths (Table 3).

Table 3. An overview of the five school programmes selected to represent the status of sustainability education, analysed by interviews with practitioners and teachers, and observations.

<table>
<thead>
<tr>
<th>Type of OSSEI</th>
<th>Name of Institution</th>
<th>Town and Region</th>
<th>School Programme</th>
<th>Target Age Range</th>
<th>Session Length (minutes)</th>
<th>Sustainability Topic(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural history museum</td>
<td>Natural History Museum Aarhus</td>
<td>Aarhus, Jutland</td>
<td>United Nations Sustainable Development Goals – Our World</td>
<td>Grade 1-10</td>
<td>60</td>
<td>SDGs</td>
</tr>
<tr>
<td>Science &amp; technology museum</td>
<td>Danish Museum of Science &amp; Technology</td>
<td>Helsingør, Zealand</td>
<td>Inventions</td>
<td>Grade 4-6</td>
<td>90</td>
<td>Technology</td>
</tr>
<tr>
<td>Science centre</td>
<td>Ecolarium</td>
<td>Vejle, Jutland</td>
<td>Robot Programmer</td>
<td>Grade 4-10</td>
<td>150</td>
<td>Technology, plastic pollution</td>
</tr>
<tr>
<td>Zoo</td>
<td>Odense Zoo</td>
<td>Odense, Funen</td>
<td>Threatened Animals</td>
<td>Grade 4-10</td>
<td>60</td>
<td>Biodiversity conservation</td>
</tr>
</tbody>
</table>
RESULTS: THE STATUS OF SUSTAINABILITY EDUCATION

Four themes emerged from thematic analysis of practitioner interviews, teacher interviews and programme observations: institution, formal education, content and pedagogy (Figure 4). Twelve sub-themes were identified within these themes, presented in the following. The theme ‘content’ contains two sub-themes that emerged deductively from earlier research: spatial scale and inclusion (Evans & Achiam, 2021).

<table>
<thead>
<tr>
<th>Institution</th>
<th>Formal Education</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional Specialisation</td>
<td>Curriculum</td>
<td>Spatial Scale</td>
</tr>
<tr>
<td>Mission</td>
<td>School</td>
<td>Inclusion</td>
</tr>
<tr>
<td>Increased Sustainability Focus</td>
<td>Pre &amp; Post-visit</td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. A thematic map representing the four themes and corresponding 12 sub-themes.

Institution

The theme of institution refers to the ways in which the specific type of institution (i.e. natural history museum, or zoo) interacts with the design or implementation of the programme. The reader will recall that the researcher found five types of OSSEIs of interest for this study. The following five sub-themes were identified: institutional specialisation, mission, sustainability policy and institutional practice (in terms of the SDGs), increased sustainability focus and collaboration.

Institutional specialisation

Institutional conditions constrain practice, and define the areas of strength and expertise available for sustainability education (Evans & Achiam, 2021). All interviewed practitioners emphasised the specialisation (i.e. unique conditions and focus) of their institutions, and how this allowed them to offer experiences for visiting students not found in schools or other educational sites. Practitioners from Natural History Museum Aarhus and Danish Museum of Science & Technology emphasised the importance of their collections in engaging with sustainability, for instance using the historical consciousness imparted by their collections to disseminate the future. Practitioners from Natural History Museum Aarhus and Odense Zoo discussed how their specimens and live collections provide a different perspective to nature, while the practitioner of Ecolarium focused on experiential aspects, such as engaging senses and creating emotion. The zoo and aquaria practitioners focused on their live animals in terms of the special feelings they prompt among learners, as well as the high level of nature expertise among staff. The practitioner of National Aquarium Denmark viewed their close proximity to the sea as an important component in their education, while the practitioner of Odense Zoo emphasised the importance of visitors viewing animals not normally seen. Finally, institutional specialisation played important roles in the exercises of the observed programmes. For example, collections at Danish Museum of Science & Technology were presented as inventions (and...
used in exercises), while exercises at National Aquarium Denmark involved two fish species (common goby and coral shark), and a brine shrimp.

**Mission**

The missions of OSSEIs play an important role in framing their education practices (Patrick et al., 2007). Indeed, in four of the practitioner interviews carried out here, the institutional mission seemed to significantly influence sustainability practice. For example, Natural History Museum Aarhus works to ‘do research within natural sciences and to promote knowledge of scientific research’ (Naturhistorisk Museum, n.d.), and the practitioner made connections to this by discussing how their research and practice works to inspire students to gain knowledge of science and nature. A similar ambition was observed in the interview with the practitioner from the Danish Museum of Science and Technology, who invoked the museum’s mission to ‘inspire creativity and innovation’ (Teknisk Museum, 2021) in their discussion of how they have a moral obligation to make children interested in how to be involved in changing the world. The practitioner of Ecolarium placed an emphasis on their role of acting as translators of different scientific topics, which connects to their sustainability focused mission of ‘enabling guests to make sustainable choices through knowledge, experiences and active learning’ (Økolariet, n.d. a). The same practitioner went further and emphasised the role of students in acting as conduits of sustainability education to others (cf. Lawson et al., 2018, 2019):

> Students visit with school and become ambassadors. They tell their parents and grandparents, then come back to visit as a family. [The] younger the students, the more likely this is to happen (Practitioner, Ecolarium).

Finally, Odense Zoo’s mission is ‘to engage in serious animal and nature conservation and research, reflected by the practitioner focusing on saving animals and nature (Odense Zoo, n.d.).

**Sustainability Policy and Institutional Practice: The SDGs**

The SDGs play a prominent role in sustainability policy (Sterling et al., 2017), and so unsurprisingly, they appeared regularly in practitioner interviews when discussing sustainability practice. However, practitioners expressed differences in how their institutions approach the SDGs; being explicit in three of the selected programmes and not mentioned in two. The practitioner of Natural History Museum Aarhus explained that pressure from leadership had prompted a greater focus on the SDGs within practice, leading to the creation of an exhibition and school programme (United Nations Sustainable Development Goals – Our World). Ecolarium practice focuses on sustainability, reflected by the inclusion of the SDGs in all exhibitions and school programmes. Their website has a page titled ‘what are the United Nations Sustainable Development Goals?’ with interactive videos and links for further information (Økolariet, n.d. b). In the observed programme Inventions at Danish Museum of Science and Technology, the SDGs form part of the introductory presentation, framing the concept of sustainability and the global challenges of relevance for the session, i.e. plastic pollution and technological solutions. In comparison, both zoo and aquaria practitioners expressed how the SDGs were unsuited for their institutional practice. The practitioner of National Aquarium Denmark described the SDGs as being too large-scale for their practice, and as a ‘wish-list’ that they ‘[implicitly] aim to connect with the real world, via methods and basic scientific knowledge, for example through physiology and biology’ (Practitioner, National Aquarium Denmark). Further constraints expressed by zoo and aquaria practitioners included the complexity of the SDGs for younger students, the short amount of time allotted for providing a fun and educational school programme, and issues relating to marketing (and space), such as already having a large amount of signage informing visitors of different topics and campaigns.

**Increased Sustainability Focus**

The importance of sustainability for society is growing. The practitioner from Ecolarium indicated that their increasing visitor numbers (doubled over the last decade) were evidence of this growing importance. Another indication of an increased interest in sustainability, discussed by the practitio-
The practi-"tioner of National Aquarium Denmark, is the large number of students contacting the institution every year with questions regarding what they can do to save the world. Generally, all OSSEI practitio-
ners emphasised an increasing focus on sustainability in their external practices, i.e. exhibitions and programmes. The practitioner of Natural History Museum Aarhus explained how their practice has changed to focus more on science, (i.e. through incorporating the SDGs into practice), compared to the previous foci of animals and nature. The practitioner of Danish Museum of Science and Technology discussed how the institution is evolving to incorporate more present-day themes into practice (i.e. by incorporating the SDGs into the school programme Inventions), while at the same time maintaining their embodied and more traditional historical consciousness. The practitioner of Ecolarium discussed the process of updating content of their school programme, Robot Programmer, in order to contain elements of sustainability practice:

Over past 12 years, the programme has changed from being just programming robots and about those used to explore the surface of Mars, to now be focused on sustainability topics like plastic pollution and how this issue can be solved using robots, i.e. the large ocean plastic gyres (Practitioner, Ecolarium).

The practitioner of Odense Zoo was the only interviewee to mention a greater internal focus on sus-
tainability, through the banning of plastic straws and all products containing palm oil.

Collaboration
The transdisciplinary nature of sustainability science calls for participatory processes with the in-
tegration of different forms of knowledge involving stakeholders across society (Craps, 2019). Two practitioners emphasised examples of collaborating with stakeholders. Danish Museum of Science & Technology regularly works with universities and local companies, ensuring that museum practice stays up to date with a fast changing modern society. The practitioner of Ecolarium acknowledged the role of outside experts, and that the majority of their staff are not scientists. For example, a robotics professor at a Danish university was involved in developing the school programme, Robot Programmer.

Formal Education
The theme of formal education contained the three sub-themes of curriculum, school and pre & post visit.

Curriculum
The curriculum is an important part of the formal education system, and as discussed, sustainability forms an important part of the Danish school curriculum. Four practitioners emphasised the influence of the school curriculum in designing their programmes. The practitioner of Natural History Museum Aarhus spoke of the need to follow the curriculum, by highlighting an increasing focus within the Dan-
ish curriculum on the SDGs (reflected by the institution’s incorporation of the SDGs into practice). The practitioner of Odense Zoo discussed the speed at which the curriculum changes. In addition, four practitioners emphasised the importance in providing an appealing proposition for teachers, and two teachers highlighted curriculum links as an important reason for booking the programme.

School
Sustainability education, such as on climate change, usually occurs within the school classroom en-
vironment (Sellmann & Bogner, 2013). Teachers gave many reasons (in addition to curriculum links) for booking the programme. These included the close proximity to school, free entry, the fun and entertaining experiences for students, the benefit of having someone else teaching the students, and students’ enjoyment of being out of school. The practitioner of Odense Zoo discussed the challenges faced by teachers in educating their students on climate change, and the role their institution can play:
Climate change is a part of what teachers are required to teach children. It is a very difficult topic for teachers - a dark subject, sad and worrying. Teachers often run away from it, so it is much easier to hand it over to the zoo to do instead (Practitioner, Odense Zoo).

In addition, the same practitioner highlighted the school classroom as being a more suitable environment for disseminating the SDGs to students, stating that the ‘SDGs are a teacher’s job on a wet Thursday afternoon – to show how the world is working together’ (Practitioner, Odense Zoo).

**Pre & Post Visit**

It is important to briefly acknowledge the potential educational limitations of a school programme, such as their often short duration and one-off instance. This in turn places greater emphasis on the pre and post visit work carried out by the teachers and students. In the interviews with the teachers, a broad variation of ways to prepare students for the education programmes was noted, as well as a variety of ways to follow up on the visit. Pre-visit work ranged from no preparation, a brief discussion on expected behaviour, watching a relevant film, to finally, a ‘facts day’ covering the focal problem (i.e. plastic pollution) and the sources of it (i.e. plastic bags). Furthermore, school location determined whether the class stayed to explore the institution after the programme, or headed straight back to school. The majority of observed classes had travelled far by bus, meaning the trip was a half or full day visit, and so spent time walking around the institution. Looking longer-term, all observed classes planned to refer back to the programme when covering related topics, such as robots or plastic pollution in the classroom. One class planned to carry out a project on robots; however, sustainability was not a compulsory element. Another class planned to build upon the programme The Sea Sweats & Plastic Fantastic, by using art and music to encourage pro-environmental behaviour in the local area.

The class is making a whale sculpture to be moved around the city while they pick up rubbish. The sculpture will have QR codes for further information. The class will sing the famous Danish song called ‘Hvalen Hvalborg’ (a song about whales created by the Danish pop group, Shubi-dua) while walking around the city (Teacher attending the programme The Sea Sweats & Plastic Fantastic at the National Aquarium Denmark).

**Content**

The theme of content contained the two sub-themes of spatial scale and inclusion.

**Spatial Scale**

Sustainability science and policy work at both the global and local scales (Evans & Achiam, 2021). In addition to a strong global component, all five selected programmes address the local spatial scale in different ways. Inventions starts by discussing the work of Jacob Ellehammer, a famous Danish inventor, with his aircraft hanging above the students (Figure 5).
Figure 5. An educator at the Danish Museum of Science and Technology teaching students about the inventions of Jacob Ellehammer, a famous Danish inventor.

A treetop walkway, focused on Danish nature, forms part of Threatened Animals. The common goby, used in The Sea Sweats, inhabits Danish waters and is often found by students when rock pooling. Robot Programmer ends with showing a video of Henrik Sharfe, a Danish professor who designed a look-alike robot. The practitioner of Ecolarium emphasised the focus within their exhibitions on local areas (visited by school classes towards the end of the programme):

Many of Ecolarium’s exhibitions are about local areas, e.g. Vejle fjord and Vejle river valley, with links to environmental issues affecting them. Local students can relate to them, and they can compare them to other locations found across Denmark (Practitioner, Ecolarium).

Another way to address the local scale is pro-environmental behaviour. Four programmes focus on individual actions students can realistically engage in within their local area to make a positive difference. Conversely, UN SDGS – Our World attempts to operationalise pro-environmental behaviour within a more globally orientated framework of sustainability, by asking students to choose the five goals most important to their own lives.

Inclusion
OSSEIs are increasingly working to become more inclusive and accessible (e.g. Achiam & Sølberg, 2017); at the same time, equality is a central element of sustainability. Two of the practitioner interviews emphasised aspects of inclusion in terms of age and gender. The practitioner of Danish Museum of Science & Technology referred to a discussion that takes place with students as part of the programme Inventions, on the appearance of Jacob Ellehammer:
He looks like a classic inventor... old man, beard... but not all inventors look like this these days – everybody can do it [invent], any gender (Practitioner, Danish Museum of Science and Technology).

The practitioner of Ecolarium presented a further example of inclusion, when discussing the development of the programme Robot Programmer. The practitioner explained how the international study on the Relevance of Science Education (ROSE) (see Sjøberg & Schreiner, 2005) found robotics to be relevant for boys and girls. This research finding led to Ecolarium designing a robotics exhibition and corresponding school programme.

Pedagogy
In this context, pedagogy refers to the content-independent methods of teaching sustainability science and policy in the selected school programmes. Evidence was found of two pedagogical strategies, framing and problem solving.

Framing
Framing is a psychological concept that describes how different perspectives can be taken on a particular issue (Chong & Druckman, 2007) and how those perspectives can affect subsequent decision-making. Three practitioners discussed elements of framing within their programme. Practitioners from Natural History Museum Aarhus and National Aquarium Denmark emphasised the importance of not finger pointing. Instead, their approaches focus on promoting hope through empowering and inspirational stories. The practitioner of Odense Zoo discussed how the framing of Threatened Animals has changed, from previously being very negative, to now focusing on solutions and what students can do to make a positive difference.

Problem solving
Much of sustainability research focuses upon problem-solving (Gendron et al., 2017), and indeed, all the observed programmes contained elements of problem-solving within their exercises. They all followed a two-part structure, with brief presentations followed by exercises. Both Inventions and Robot Programmer included one generic and one sustainability exercise, while The Sea Sweats & Plastic Fantastic included two sustainability exercises.

The first exercise in Inventions asked students to search for an invention within a designated area of the museum and consider the problem that it solves. The following sustainability exercise built on this knowledge, and asked students in groups (using a set of materials) to design an invention that could help to solve a problem in relation to an SDG (i.e. Figure 6, a boat designed to remove plastic in the ocean using a net).

![Figure 6. A group invention made at Danish Museum of Science & Technology.](image)
In Robot Programmer, the first exercise led to students in groups programming their robots to travel back and forth between two designated lines, as quickly and precisely as possible. This turned into a competition, with a final taking place between the two closest groups (Figure 7).

Figure 7. At Ecolarium, two groups compete in a final in programming a robot to travel to and from designated lines.

The second exercise asked students to programme their robots to collect plastic from the ocean. Finally, The Sea Sweats & Plastic Fantastic took the form of two scientific experiments centred on the ‘wicked problems’ (cf. Rittel & Webber, 1973) of climate change and plastic pollution. In groups, students measured the number of gill beats of a common goby and coral shark, and discussed their adaptations to a warming ocean. The secondary exercise involved students feeding food dye to brine shrimps and observing the take up through a microscope, simulating the ingestion of micro-plastics by marine animals.

DISCUSSION
It was earlier discussed that the strong foundation of sustainability within Danish society may prompt a range (and depth) of sustainability education initiatives, shaped by the strengths and expertise of Denmark’s OSSEIs. Accordingly, this study sets out to investigate the scope and status of sustainability education across Denmark. The results demonstrated a lack of sustainability programmes, however, those found contained a certain richness of sustainability topics across the five types of OSSEIs. Before these results are discussed and their implications for research and practice, the limitations of the study are briefly outlined.

Limitations
As a reminder, the OSSEIs of interest for this study were affiliated with the natural sciences and offering natural science education programmes. However, the researcher acknowledges how other disciplines, for instance art, play increasingly important roles in sustainability education (e.g. Crossick & Kaszynska, 2016; Heinrichs, 2018). Further, although botanical gardens make important contributions to out-of-school science education (e.g. Sellmann & Bogner, 2013), the desktop review did not find examples of these institutions offering sustainability programmes. Finally, a lack of programme information on OSSEI websites occasionally hindered the desktop review, presenting a dilemma of whether content adhered to the criteria.
Relative Scarcity of Sustainability Programmes

This study of the scope of sustainability education indicate that all five types of OSSEIs in Denmark offer sustainability education for visiting school classes. Even so, only about one fifth of the reviewed programmes contained sustainability content according to my criteria. Given the general focus on sustainability in Danish society, and the recent Decade of Education for Sustainable Development (2005-2014) (UNESCO, 2005); it would have been expected to find a far greater presence of sustainability in school programmes. Why is sustainability not more in focus?

One reason for the relative scarcity of sustainability programmes could be the fuzziness and complexity of the notion of sustainability, which makes it difficult to operationalise for out-of-school education (Brown, 2019; Evans & Achiam, 2021). Another reason could be that the SDGs, which have become the de-facto conceptualization of sustainability in society (Sterling et al., 2017), do not always fit comfortably within the specific strengths and expertise of Danish OSSEIs. These results indicate that the type of institution strongly co-determines the sustainability content of the observed programme. This means, for instance, that for zoos and aquaria, designing sustainability programmes based on the SDGs is relatively straightforward, because SDG 14 (Life Below Water) and 15 (Life On Land) fit these institutional specialisations well. In fact, the most frequent topic for sustainability programmes in this study was biodiversity conservation, with zoos and aquaria offering over two-thirds of the sustainability programmes. Furthermore, the recent sustainability strategy released by the World Association of Zoos and Aquaria (WAZA) focuses heavily on encouraging their member institutions to work with the SDGs (WAZA, 2020). However, interviews with zoo and aquaria practitioners discovered opposition to the explicit inclusion of SDGs into institutional practice. Many of their criticisms resonate with those expressed in academic circles (i.e. Liverman, 2018).

Aside from target 11.4, ‘strengthen efforts to protect and safeguard the world’s cultural and natural heritage’ (UN, 2015), there are no SDGs that have the same one-to-one correspondence with natural history museums, science and technology museums or science centres. This probably means that these institutions must develop other focus points for sustainability education. One example is the interdisciplinary wicked problem of climate change (Cross & Congreve, 2020), which indeed was the only topic present across all five types of OSSEIs. As a counterpoint to this, museums, science centres and other OSSEIs are increasingly being tasked with educating the public for a sustainable future (e.g. Janes & Grattan, 2019; Janes & Sandell, 2019). Recent discussions in organizations such as the International Council of Museums or the Science Centre World Summit seem to reflect this ambition; however, quantitatively speaking, the researcher find themselves in agreement with Wals, (2010) who considers the level of democratic led action in sustainability education in Denmark to be insufficient to adapting to and mitigating the global sustainability challenges.

The Influence of Formal Education

The output of the status of sustainability education produced four themes, including that of formal education. Results from the thematic analysis indicate the influential role on OSSEI practice played by schools and the curriculum. The more reductionist school curriculum differs greatly to the systems-based approach taken by OSSEIs, with school subject boundaries running counter to the interdisciplinary and problem-based nature of sustainability. As shown from the interviews with teachers, they may struggle to conduct worthwhile pre and post activities because of these things. Research has shown how students’ prior knowledge affects a visit to an OSSEI (i.e. Beiers & McRobbie, 1992). The teacher has an important role to play here in the form of mediating such a visit, particularly as OSSEI practitioners find it challenging to offer experiences fitting perfectly with students' prior knowledge (DeWitt & Storksdieck, 2008).

The close association of school curricula and OSSEI practice is perhaps hindering progress on sustainability education in programmes for visiting schools and contributing to the scarcity of sustainability education found in this study. Limiting themselves to the curriculum content perhaps makes it more difficult for OSSEIs to play to their areas of strength and expertise (see Evans & Achiam,
2021). Many OSSEIs maintain their own elements of scientific research, and so avoid the delay seen in formal education, caused by the need for research to be published and then added into curricula and corresponding material (Berg et al., 2021). A close association with the school curriculum potentially erodes away at this unique position. Finally, however, this is balanced with acknowledging the importance of OSSEIs in attracting visiting school classes, confirming their educational purpose in a rapidly changing society. Maintaining strong curriculum links within a programme may give greater meaning to a visit and can ensure the support of school leadership. Wolins, Jensen & Ulzheimer, (1992) found that curriculum links added to the long-term impact of school field trips to an OSSEI.

Pedagogy of Sustainability Education
Sustainability education aims to produce transformative learning experiences (Marouli, 2021) leading to a greater educated and motivated citizenry, by using pedagogical tools such as problem solving, critical thinking and decision-making (Thomas, 2018). Framing and problem solving were the main pedagogies found within the sustainability programmes. When framing programme content, the balance between disseminating a more positive outlook and human caused sustainability challenges can be very difficult to achieve (Esson & Moss, 2013). Programme observations provided a detailed insight into problem solving within sustainability education, with this method of learning a solution to preparing students for the challenges of sustainability. OSSEIs are well placed to provide problem-based learning, due to their close association with society and the complex, real-world issues we all face (Berg et al., 2021).

CONCLUSION
It is important to note the constraints that OSSEI programme developers and educators are under in producing effective sustainability education, including funding, leadership, the level of expertise required, and the short time for an education session. In the light of the results of this study and in relation to prior research, it is essential that OSSEIs move away from a more reactive approach to sustainability policy (i.e. curriculum changes and specialised organization initiatives), to allow for a more proactive thinking mind-set within sustainability practice, using their unique areas of expertise. Taking into account the strong foundation of sustainability in Danish society, curriculum focus on sustainability and the SDGs, coupled with the urgent level of global action required, it is not overly ambitious to suggest that the majority of school programmes contain explicit, action-orientated sustainability content. With the global nature of sustainability challenges, the researcher hopes that scientists, policymakers and practitioners across Denmark and further afield view these findings to be of use moving forwards.

ACKNOWLEDGEMENTS
Thanks are due to my PhD supervisor, Marianne Achiam, for her support. In addition, I would like to thank the practitioners and teachers for their help and patience during data collection.

DECLARATION OF INTEREST STATEMENT
The author is unaware of any conflicts of interest, financial interest or benefit that has arisen from the direct applications of this research.

REFERENCES


Sjøberg, S., & Schreiner, C. (2005). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE. Asia Pacific Forum on Science Learning and Teaching, 6(2), 1-16.


Wals, A. E. J. (2010). Between knowing what is right and knowing that it is wrong to tell others what is right: On relativism, uncertainty and democracy in environmental and sustainability education. Environmental Education Research, 16(1), 143–151. https://doi.org/10.1080/13504620903504099


