



Ranking the sustainable development goals: perceived sustainability priorities in small island states

Maarten B. Eppinga¹  · Eric N. Mijts² · Maria J. Santos¹

Received: 29 March 2021 / Accepted: 25 November 2021
© The Author(s) 2022

Abstract

The Sustainable Development Goals (SDGs) aim to elicit global mobilization to implement the 2030 Agenda for Sustainable Development, and are increasingly used in support of Education for Sustainable Development (ESD). Previous studies have highlighted interdependencies between SDGs, with potential interactions between four Sustainability Domains: Economy, Governance, Planet and Society. This study aimed to assess whether people's perception of the relative importance of the SDGs reflects recognition of the need to prioritize efforts across Domains, or whether this perception is based on different valuations of the Sustainability Domains themselves. We designed an interactive online tool in which participants used the Q-sort technique to rank the SDGs according to their subjective valuation of importance. We analyzed the rankings of 108 participants, all learners at universities in three Small Island States (SIS): Aruba, Suriname and Trinidad and Tobago. Analysis of the correlation structure among participants' Q-sorts showed that higher perceived importance of the Society- and Economy-related SDGs 2, 3, 4, 8 and 9 traded off with lower perceived importance of the Planet-related SDGs 13, 14 and 15. Furthermore, SDG rankings of learners from Aruba occurred furthest toward the Planet-based part of this trade-off axis. For ESD programs, our method provides a novel tool to identify key interactions between SDGs that may not yet be recognized by program participants. In this way, communicating the need for simultaneous action and policy development across Sustainability Domains could be specifically tailored to the local context. Such connections may increase the effectiveness of ESD in addressing the substantial sustainability challenges facing SIS.

Keywords Caribbean · Education for Sustainable Development · Interactive online tool · Small island sustainability · Trade-off · Q-sort technique

Introduction

Following up on the Millennium Development Goals (MDGs), the Sustainable Development Goals (SDGs) aim to elicit global mobilization to implement the United Nations' 2030 Agenda for Sustainable Development (Sachs 2012;

UN 2015). This next generation of goals more prominently recognizes the economic, social, environmental and governance dimensions of sustainability (Fukuda-Parr 2019). The origins of the SDGs can be traced back to reports as issued by the Club of Rome, which noted that sustained economic growth needs to be accompanied by increased environmental protection (Meadows et al. 1972; UNCED 1992). Later notions, as put forth by the Brundtland Commission and others, highlighted that global social development also plays a key role (Brown et al. 1987; Brundtland Commission 1987; UN 1995). Subsequently, while partially targeted through the MDGs, it has been recognized that good governance and further investments in international partnerships are also required (Sachs 2012; Hák et al. 2016; Caradonna 2017). This evolutionary process emphasizes the increasingly holistic view on the sustainability transition (UN 2015; Biermann et al. 2017; Delli Paoli and Addeo 2019). Hence, the SDGs

Handled by Fabrice Renaud, University of Glasgow, United Kingdom.

✉ Maarten B. Eppinga
Maarten.Eppinga@geo.uzh.ch

¹ Department of Geography, University of Zurich, Winterthurerstrasse 190, 8057 Zurich, Switzerland

² Rectorate, Academic Foundation Year and Sustainable Island Solutions Through STEM, University of Aruba, J.E. Irausquinplein 4, Oranjestad, Aruba

can be considered a potentially important step towards an integrated perspective on sustainability (Sterling 2016; Pradhan 2019).

While there is a broad recognition of the interdependencies between the SDGs (Dora et al. 2015; UN 2015; Nunes et al. 2016; Miola et al. 2019; Pham-Truffert et al. 2020; Reyers and Selig 2020), this dependency has not been formalized within its implementation framework (Nilsson et al. 2016). This is exemplified by the observation that SDGs are (still) presented with a silo or domain-based approach (ICSU and ISSC 2015; UN 2015; Sterling 2016), which may also be reflected in the implementation of SDG-based policies (Allen et al. 2018; Nhamo et al. 2020). In this context, it is important to note that the capacity to fully implement all SDGs may not be available, which means that prioritization may become a necessary component of the policy process (Allen et al. 2018). Hence, while simultaneous actions in the economic, social, environmental and governance domains are currently needed (Costanza et al. 2016b; Khoshnava et al. 2019), concern has risen that priorities are unevenly distributed across these sustainability domains (Holden et al. 2017; Forestier and Kim 2021). For example, a review of national policy documents revealed that countries may prioritize SDGs related to economy and society over those that are aligning more closely with the environmental and governance domains (Forestier and Kim 2021). Furthermore, case studies have suggested that this prioritization process may be based on policies that were already in place prior to adoption of the SDGs, which would reduce the influence of the SDGs in steering the policy process (Forestier and Kim 2021).

This domain-based approach to presenting the SDGs can be partly explained by their emergence as a compromise that resulted from intergovernmental discussions, reflecting a multiplicity of concerns and interests (Le Blanc 2015). It has been argued that more holistic approaches are needed, which could start from a coherent systemic view of the linkages and feedbacks between the economic, social, environmental and governance components of the Earth System (Le Blanc 2015; Di Baldassarre et al. 2019; Scharlemann et al. 2020; Yang and Cormican 2021). Such approaches, aiming to circumvent unbalanced consideration of the different sustainability domains, include recent efforts to identify entry points for sustainability transformations within the underlying systems, rather than focusing on achieving individual or even clusters of SDGs (GSDR 2019; Messerli et al. 2019; Sachs et al. 2019; Skene 2021).

In addition to mobilizing efforts to implement the 2030 Agenda for Sustainable Development, the SDGs also provide a means to support Education for Sustainable Development (ESD) programs (Annan-Diab and Molinari 2017; Agirreazkuenaga 2019; Eppinga et al. 2020; Kopnina 2020a, b). This interconnection between ESD and the SDGs is reflected

within SDG target 4.7, which aims: ‘to ensure (by 2030) that all learners acquire the knowledge and skills needed to promote sustainable development’ (UN 2015). Other examples of this interconnection can be found in the recognition within the SDGs of the need for education on issues such as climate change mitigation and adaptation (Eppinga et al. 2019). Furthermore, the presented vision that no one should be left behind (UN 2015) also implies that no citizen should be denied the opportunity to take ownership of the 2030 Agenda for Sustainable Development and be empowered to become agents of change realizing its SDGs (Chin and Jacobsson 2016; Eppinga et al. 2019, 2020).

Within the context of ESD programs, synergies and trade-offs may exist in communicating the importance of individual SDGs on the one hand and the need for concerted action in all sustainability domains on the other hand (Costanza et al. 2016a; Holden et al. 2017; Lozano et al. 2017; Cottafava et al. 2019). The former perspective may be dominant when ESD is confined to specific courses emphasizing a particular domain of sustainability, or when it is offered through add-on electives to learners already interested in specific aspects of sustainability (Moore 2005; Guerra 2017). Such an isolated treatment is unfortunate, as sustainability is best taught not as a management problem within a single domain (DeLind and Link 2004; Wiek et al. 2015; Eppinga et al. 2020). When using the SDGs within ESD, learning plans that introduce SDGs in a way that communicates to learners the need for an integrated approach to sustainability, which cuts across traditional domains, would likely be conducive to learners developing a holistic view on sustainability (Wiek et al. 2015; Lozano et al. 2017, 2019). Whether the formulation of the 17 SDGs is conducive to fulfilling this function in ESD can be addressed by recording learners’ perceptions of the relative importance of each SDG. Specifically, for learners assigning similar levels of importance to SDGs from different domains, introduction of the 17 SDGs by itself may already be conducive to promoting a holistic view on sustainability. In contrast, more silo-based views on sustainability may be reinforced through introduction to the SDGs when learners consistently assign higher levels of importance to SDGs from one domain as compared to another domain. Thus, investigation of learners’ perceptions of the relative importance of each SDG may indicate whether the SDGs primarily convey the importance of individual SDGs or single sustainability domains, or whether they highlight the need to prioritize concerted action across domains.

While the SDGs have been designed to provide guidance for sustainable development for all countries of the world, the perceived relative importance of SDGs may vary substantially between states (Horn and Grugel 2018). In this context, Small Island States (SIS) face substantial sustainability challenges, including the conservation of unique biodiversity and pivotal marine resources, as well as coping

with scarce human resources (Teelucksingh et al. 2013; Sloan et al. 2014; De Scisciolo et al. 2016; Connell 2018; Eppinga et al. 2019). Within SIS, the need for concerted action across sustainability domains is often highly visible, when considering the challenges related to (eco-)tourism and environmental impacts, for example (Robinson et al. 2019). More generally, the importance of a holistic view on sustainable development of SIS has been previously emphasized in terms of the need for coordinated action (Leotaud and Cadiz 2013), meeting anticipated changes in environmental conditions (Teelucksingh et al. 2013; Eppinga and Pucko 2018; Van Beynen et al. 2018), and by advocating the need for reducing vulnerability and increasing resilience of SIS (Hay 2013; Briguglio 2014; Connell 2018). Examination of SIS learners' perceptions of the relative importance of each SDG may thus provide an interesting case study to assess the extent to which introduction of the SDGs themselves in ESD may aid in promoting a holistic view to taking ownership of implementing the 2030 Agenda for Sustainable Development in SIS.

The Q methodology has been proposed as a technique to identify patterns in people's subjective perceptions around a particular topic (Stephenson 1935; Brown 1993, 1996,

2005). The method provides an alternative to more traditional survey-based approaches that invite participants to evaluate questions using a Likert- or similar scales (Cross 2005). A potential disadvantage of these latter type of methods is that answers tend to center around the mean, creating little variation within and among participants, and therefore obscuring potential trends of interest (ten Klooster et al. 2008; Ho 2017). In contrast, the Q methodology invites participants to rank quotes or statements (such as the SDGs) relative to each other using a so-called Q-grid (Fig. 1): a fixed distribution over the rank categories considered (e.g. Coogan and Herrington 2011). Hence, the analysis can be used to identify distinct groups of participants that reflect different patterns of association between the quotes or statements ranked (Watts and Stenner 2005). As part of the Q methodology, the filling of the Q-grid can be done in conjunction with an interview, in which the participant and interviewer discuss the motivations of and reflections on the sorting decisions made (e.g. Duenckmann 2010). When the Q-grid has been filled by a participant, the resulting ranking is referred to as the participant's Q-sort (e.g. Coogan and Herrington 2011). Quantitative analyses of participants' Q-sorts provide a means to detect different viewpoints held

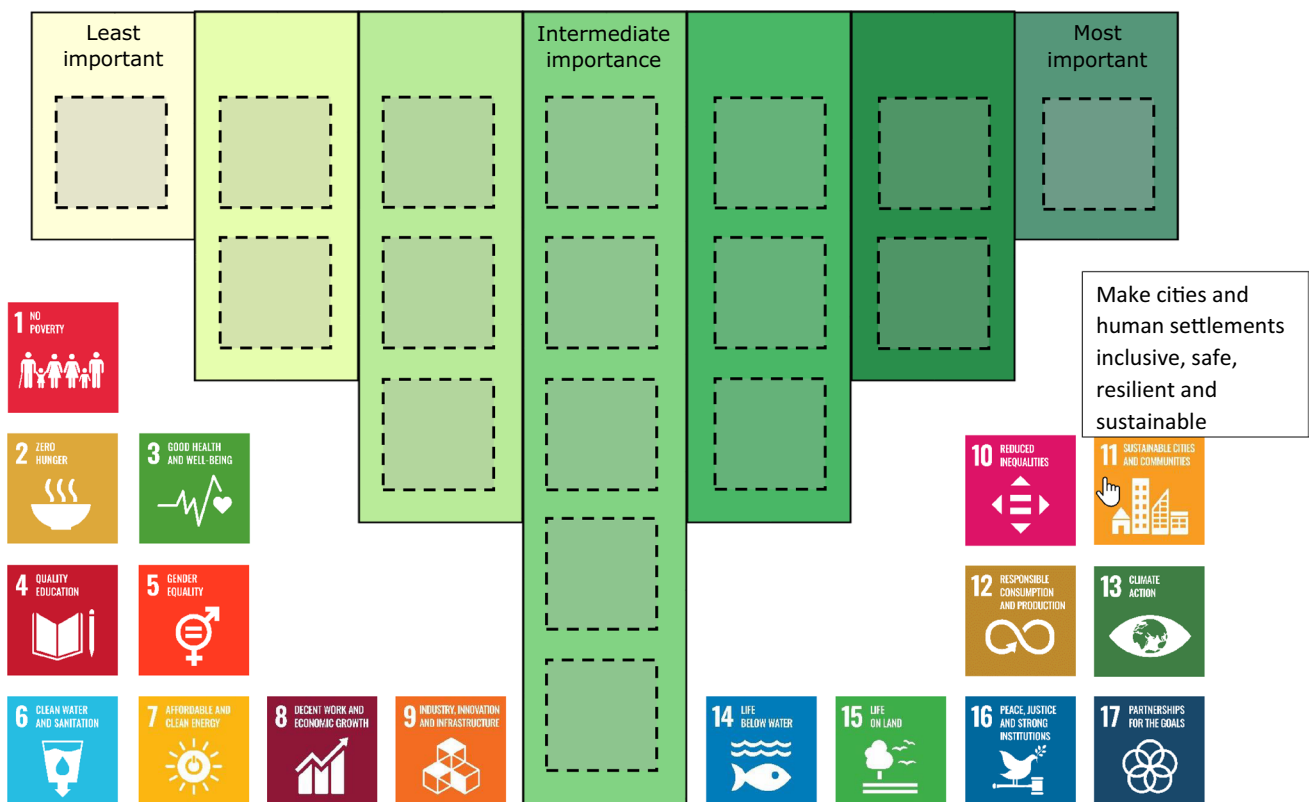


Fig. 1 Illustration of the Q-grid that was used in this study. Participants ranked the Sustainable Development Goals by filling this Q-grid, using an interactive online tool. The tool was developed with

the freely available platform h5p.org, and is available for viewing at: <http://www.h5p.org/node/706560>

among different sub-groups of participants (Brown 1993, 1996; Martin and Steelman 2004; Curry et al. 2013). Importantly, factor analysis is not performed using the participant scores directly, as is common in more conventional R factor analysis (*sensu* Stephenson 1982). Instead, Q factor analysis uses the correlation structure between participants' Q-sorts (Stephenson 1935; Brown 1993, 1996, 2005). Q methodology is increasingly applied in a variety of research fields, including biodiversity conservation and sustainability-related research (e.g. Barry and Proops 1999; Curry et al. 2013; Silvius et al. 2017; Iofrida et al. 2018; Zabala et al. 2018; Vaas et al. 2019; Ciftcioglu 2020).

The aim of this study was to develop a new method to assess whether the perception of learners in SIS regarding the relative importance of the SDGs reflects recognition of the need for prioritizing goals across sustainability domains, or whether this perception is based on different valuations of the domains themselves. Several studies have operationalized the multi-dimensionality of the SDGs by identifying 3–5 clusters of goals, with each cluster representing one SDG dimension (e.g. Costanza et al. 2016a, b; Folke et al. 2016; Muff et al. 2017; Dalampira and Nastis 2020; Kostoska and Kocarev 2019; Delli Paoli and Addeo 2019; Vinuesa et al. 2020). The specific clusters identified typically align with the UN paradigm of three pillars of sustainable development (i.e. the economic, social and environmental pillars, e.g. Griggs et al. 2013), or the five areas critical importance (i.e. people, planet, prosperity, peace and partnership) as subsequently proposed in the 2030 Agenda for Sustainable Development (UN 2015). Given their common basis, many similarities exist between the clusters identified in these previous studies. In the current study, we followed the approach of Muff et al. (2017) and distinguished the following four Sustainability Domains: Economy, Governance, Planet and Society.

We examined the perceptions of learners in the following three SIS that differ in their socio-economic and environmental characteristics: Aruba, Suriname and Trinidad and Tobago (Fig. 2; Table 1). Of these three SIS, Aruba is the SIS with the highest population density and per capita GDP, driven by a tourism-based economy (Manera and Valle 2018; Table 1). Aruba also has the highest life expectancy and the highest scores on governance indicators, but it has the least amount of remaining forest and protected natural area of the three SIS (Table 1). In contrast, Suriname has the largest amount of forest cover and protected area, but scores lower on the socio-economic and governance indicators (Table 1). Suriname's economy relies on natural resource extraction, in particular gold, bauxite and crude oil (Nurmohamed et al. 2008; Seccatore and De Theije 2017). Trinidad and Tobago is characterized by intermediate scores on environmental, socio-economic and governance indicators (Table 1). Trinidad and Tobago's economy largely

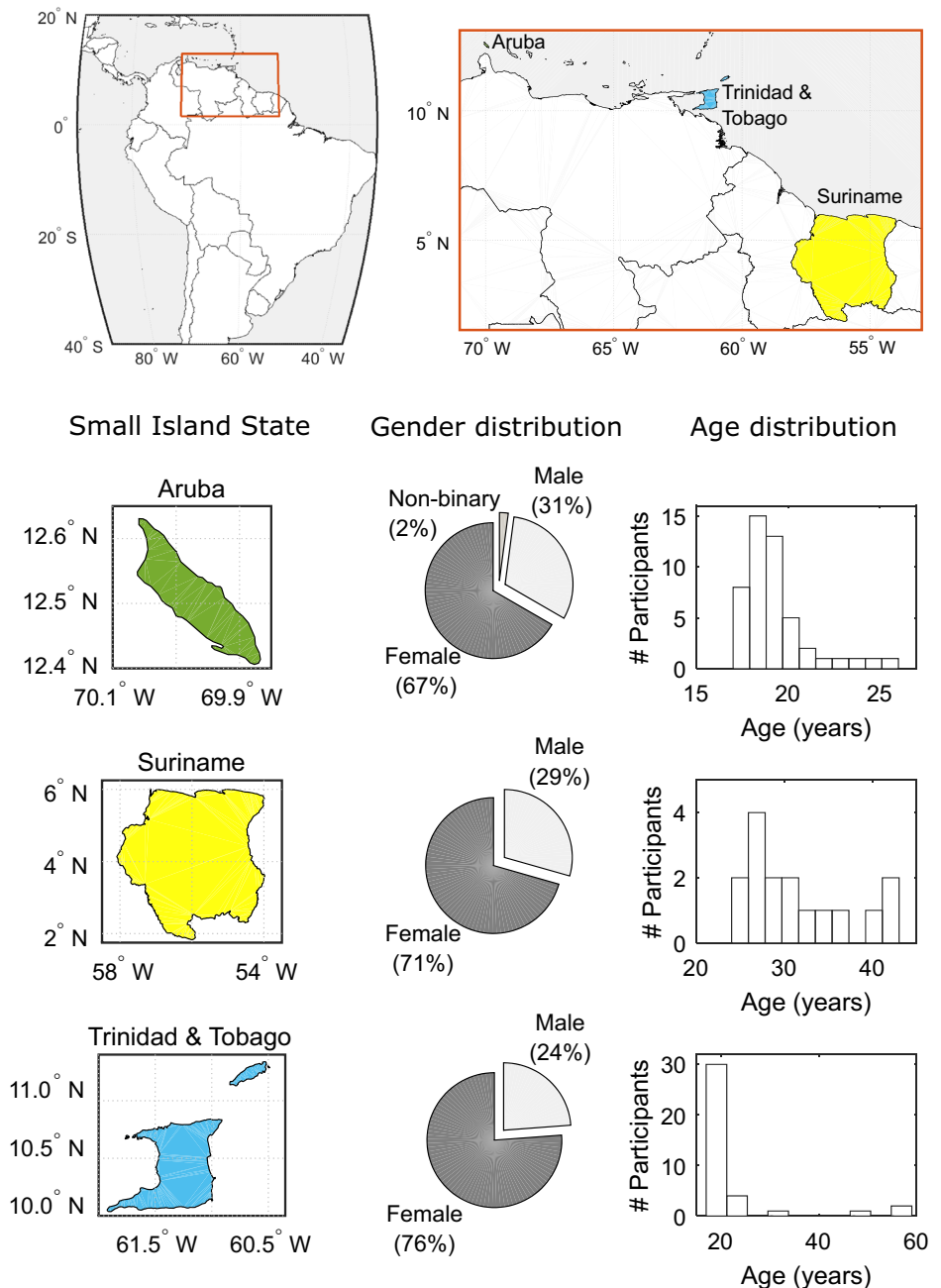
relies on energy-intensive, chemical processing industries, which benefit from the large supply of fossil fuels (Shah and Rivera 2007). We examined to what extent these different local contexts related to learners' perceptions of the relative importance of the different SDGs. Specifically, we addressed the following research questions: (1) Which SDGs and which Sustainability Domains are, on average, perceived as most important? (2) What are the major differences in learners' views on the relative importance of the SDGs, and to what extent do these differences correspond to differences in resident SIS and gender? (3) Are the main differences between learners' perceptions due to differences between goals within each Sustainability Domain, or due to differing opinions on the importance of Domains themselves?

Materials and methods

Ranking the sustainable development goals

We created an interactive online tool in which participants sorted the SDGs according to their subjective valuation of importance (<http://www.h5p.org/node/706560>). The tool was developed using the freely available platform h5p.org, which enables users to build applications that are based on the html5 markup language. Using this interactive tool, each participant in the study was asked to assign each of the 17 SDGs to one of seven categories, which ranged from 'least important' to 'most important'. Following the quantitative steps of the Q methodology, the ranking of the SDGs was constrained by a Q-grid spanning these seven categories (e.g. Brown 1996; Coogan and Herrington 2011; Fig. 1). Before participants began with the ranking of the SDGs, all participants watched an introductory video (see Supplementary Information) that included a brief background on the origin of the SDGs, as well as an introduction to each goal and their one-sentence summaries (UN 2015). The instruction video was recorded in English, (one of) the main instruction language(s) for all education programs included in this study (Nurmohamed et al. 2008; Veldhuizen-Doelahasori 2011; IGDS 2021; see below for further details). While using the interactive tool, hovering the mouse cursor over a particular SDG would again show its one-sentence summary (Fig. 1). Finally, the introductory video included technical information on how to submit the final Q-sort to the researchers of this study. Here, participants were requested to submit their final Q-sort as a screenshot on a submission form (see Supplementary Information), which also anonymously recorded the participant's age, gender, country of birth and country of residence (Fig. 2). The authors' host institutions do not provide a formal ethics review, but we followed a procedure that ensured participation of learners was on a voluntary basis. It should be noted that decentralized, online methods for

Fig. 2 Geographical locations of the three Small Island States (SIS) that were considered in this study, and details of the participant groups from each SIS. In total, 108 people participated, the largest group being from Aruba ($n=49$), followed by Trinidad ($n=42$) and Suriname ($n=17$), respectively. Gender distributions were similar for the three groups, while the average age of the group from Suriname was higher as compared to the groups from the other two SIS



conducting the Q-sort, as used in our study, exclude the possibility of interviewing the participants during or after the Q-sorting task (Yeun 2021). In the current study, this qualitative component of the Q methodology (e.g. Duenckmann 2010) was, therefore, not implemented, while the quantitative components of the Q methodology were complemented with additional quantitative analysis techniques, as further described below.

Characteristics of the study participants

A total of 108 participants completed a Q-sort that was analyzed in this study. These participants were attending universities from the SISs Aruba ($n=49$), Suriname ($n=17$) and Trinidad and Tobago ($n=42$). While Suriname is part of the continent of South America, it shares many characteristics with small islands, including a low-lying coast, a

Table 1 A brief comparison of the three Small Island States (SIS) from which learners participated in the Sustainable Development Goal ranking exercise of this study

Sustainability Domain	Economy		Governance		Planet		Society		
	GDP per capita (\$)	International Tourism (receipts, % of total export)	Government effectiveness	Regulatory quality	Forest cover (% of land area)	% Protected natural area	GINI coefficient (%)	Life expectancy	Population density (people km ⁻²)
Aruba	29,007 (1)	82.0 (1)	1.06 (1)	0.86 (1)	2.3 (3)	0.5 (3)	73.0 (3)	76.2 (1)	588 (1)
Suriname	17,256 (3)	2.7 (3)	− 0.66 (3)	− 0.65 (3)	98.3 (1)	8.5 (1)	84.6 (1)	71.6 (3)	4 (3)
Trinidad and Tobago	27,334 (2)	5.2 (2)	0.19 (2)	− 0.10 (2)	46 (2)	2.0 (2)	74.8 (2)	73.4 (2)	271 (2)

Using data from the World Bank (World Bank 2018) and the Global Wealth Report (Shorrocks et al. 2019), the SIS are compared for a couple of indicators for each of the Sustainability Domains considered in this study

high degree of geographic isolation, a high vulnerability to environmental hazards, a small (but growing) human population and an economy that heavily relies on a small number of sectors (Girvan 2005; Taglioni and Cruse 2013; NIMOS 2013). Suriname joined the group of Small Island Developing States in 1981 and has become actively involved since the evaluation of the Barbados Program Of Action in 2002 (NIMOS 2013). Regarding the current study's observations from Trinidad and Tobago, all participants attended the University of the West Indies' St. Augustine campus on Trinidad, and therefore, we will refer to this group as the learners from Trinidad from here on. All learners participated in university programs that incorporated sustainability and environmental science as part of the curriculum. The learners from Aruba were all participating in an Academic Foundation Year (AFY) program, which includes a sustainability research project in its academic core program (Eppinga et al. 2020) and offers an introduction to earth- and environmental science as an elective (Eppinga et al. 2019). The learners from Suriname all participated in either a Master program on the Sustainable Management of Natural Resources (Nurmohamed et al. 2008), or in a Master program on Education and Research for Sustainable Development (Veldhuizen-Doelahasori 2011). The learners from Trinidad were all participating in a study program within the Institute for Gender and Development Studies, in which students explore how gender analysis is central to transformation of the Caribbean region toward greater sustainability, equality and social justice (IGDS 2021). The median age of the group of learners from Suriname was higher than the two other groups (Fig. 2; Median age Suriname: 29.5, Median age Aruba: 19, Median age Trinidad: 18, Kruskal–Wallis test: $X^2_{2,99}=33.98, p=4.19 \cdot 10^{-8}$). No significant difference in the gender balance occurred between the three learner groups (Fig. 2; Chi square test: $X^2_2=0.87, p=0.65$).

Perceptions of the relative importance of individual SDGs and sustainability domains

To answer our first research question, we averaged the scores of all learners given to each SDG. Subsequently, we combined the average scores of the individual SDGs into average scores for the Sustainability Domains. As noted above, we followed the operationalization of Muff et al. (2017), who assigned the SDGs to four Sustainability Domains as follows: Economy (SDGs 8, 9, 10, 11, 12), Governance (SDGs 16, 17), Planet (SDGs 6, 7, 13, 14, 15), and Society (SDGs 1, 2, 3, 4, 5). While this operationalization shows a high degree of similarity with other clustering approaches (e.g. UN 2015; Folke et al. 2016), its distinction of four clusters, with each cluster comprising multiple SDGs, provided a suitable template to test whether a person's prioritization of the SDGs was mainly one-dimensional (i.e. when SDGs considered most important all come from the same Domain) or multi-dimensional (i.e. when SDGs considered most important all come from different Domains) in subsequent analyses, as explained in the next two sections. It should be noted that these average scores of individual SDGs and Sustainability Domains are not independent; as each Q-sort is centered around zero, positive scores on one SDG/Domain can only occur if there is a negative score on (an)other SDG/Domain(s). Hence, it is important to take into account the fixed format of the Q-sort when analyzing quantitative differences in average scores. For this purpose, we compared the observed trends with null model predictions using a randomization procedure, which is described in detail in Appendix 1.

Identifying different views on prioritization of the SDGs

To answer our second research question, we performed a cluster analysis to identify groups of participants that

distinctly differed in their perception of the relative importance of the SDGs. Once the participant clusters were identified, we examined the distribution of participants from the three SIS over these clusters. Specifically, we tested whether this distribution was different for the three SIS, thereby identifying for each SIS in which clusters its participants were over- and underrepresented, respectively. A similar comparison was made for female and male participants. Finally, we analyzed for each participant cluster whether the ranking pattern was more in line with one-dimensional or multi-dimensional prioritizations of the SDGs. Here, one-dimensional prioritization occurs when the SDGs considered most important all come from the same Domain. In contrast, multi-dimensional prioritization occurs when SDGs considered most important all come from different Domains. Details of the clustering procedure and subsequent statistical analyses and tests performed to answer the second research question are described in Appendix 1.

Identifying the main axes of variation in participants' prioritization of SDGs

To answer our third research question, we analyzed the correlation structure among the Q-sorts of all participants. While the Q-grid forces a specific ranking structure for each participant (Fig. 1), the analysis of the correlation structure between all participants can identify more general patterns, elucidating for example how higher perceived importance for specific SDGs or Sustainability Domains trades off with lower perceived importance for other specific SDGs or Sustainability Domains, and vice versa. This analysis of the correlation structure follows the quantitative steps that are part of the Q methodology (Brown 1996). Specifically, we extracted two main components explaining the correlation structure using Principal Component Analysis (PCA, see Appendix 1 for details). We then studied the positions of the SDGs within the 2-dimensional space spanned by these components. Similar to previous analyses, we assessed to what extent this procedure could detect differences in ranking strategies, in this case for the complete set of participants. Specifically, to assess the statistical power provided by this procedure, we also performed the procedure for three idealized cases using simulated data (using the same sample size as the actual data, i.e. $n = 108$): (i) Trade-offs occur only between Domains as follows: Participants always rank according to the Sustainability Domains (e.g. first choose all Planet goals as most important, followed by all Society goals in the most important positions left, etc. (Fig. 3)); (ii) Trade-offs occur only within Domains: participants always alternate between Domains (e.g. first choose one goal from the Planet Domain, then choose one goal from the Society domain, etc. (Fig. 3)); (iii) Participants rank the SDGs randomly (Fig. 3). We note that all three scenarios are subject to

the same constraints as set by the Q-sort (Figs. 1, 3). These hypothetical, simulated cases showed clear differences in the ordering of the SDGs on the first two (rotated) PCA components obtained with the Q method (Fig. 3). Where the first scenario leads to clear clustering of SDGs within the domains, no clustering is observed in the second and third scenario (Fig. 3). Hence, the type of trade-off that determines prioritization of the SDGs is reflected by the relative position of SDGs in the (rotated) principal component space (Fig. 3), thus revealing the dimensionality of participants' ranking decisions. Finally, by comparing the average position of the participants of the three SIS on each PCA component, we could assess the extent to which these participants differed in their choices related to the trade-offs identified (see Appendix 1 for further details).

Results

Average scores of the SDGs and Sustainability Domains

On average, participants of the study perceived the Society- and Planet-oriented SDGs as more important than the Economy-oriented SDGs (Fig. 4). When aggregating the average scores of the individual SDGs into average scores of the four Sustainability Domains, the Society and Planet Domains received significantly positive scores, whereas the Economy Domain received significantly negative scores (Fig. 4; Randomization test: $p < 0.0001$). In the following, we will analyze to what extent different groups of participants deviated from these overall trends.

Different views on prioritization of the SDGs

Cluster analysis yielded five groups of participants (ranging between 13 and 32 group members) that differed in their prioritization of the SDGs, and, as a result, the Sustainability Domains (Fig. 5). Following the cluster groups from the top to the bottom of the clustering tree, there was an increasing trend in the relative importance assigned to Society-related SDGs (Fig. 5). The three clusters at the top were characterized by higher relative importance assigned to the Planet-related SDGs, with the strongest preference for these goals occurring in the second cluster (Fig. 5). In the first cluster, higher relative importance was assigned to the Governance- and the Economy-related SDGs instead (Fig. 5). For the fourth and the fifth clusters, in addition to the trend in Society-related SDGs mentioned above, there was higher relative importance assigned to Governance-related SDGs in the former, and to Economy-related SDGs in the latter (Fig. 5).

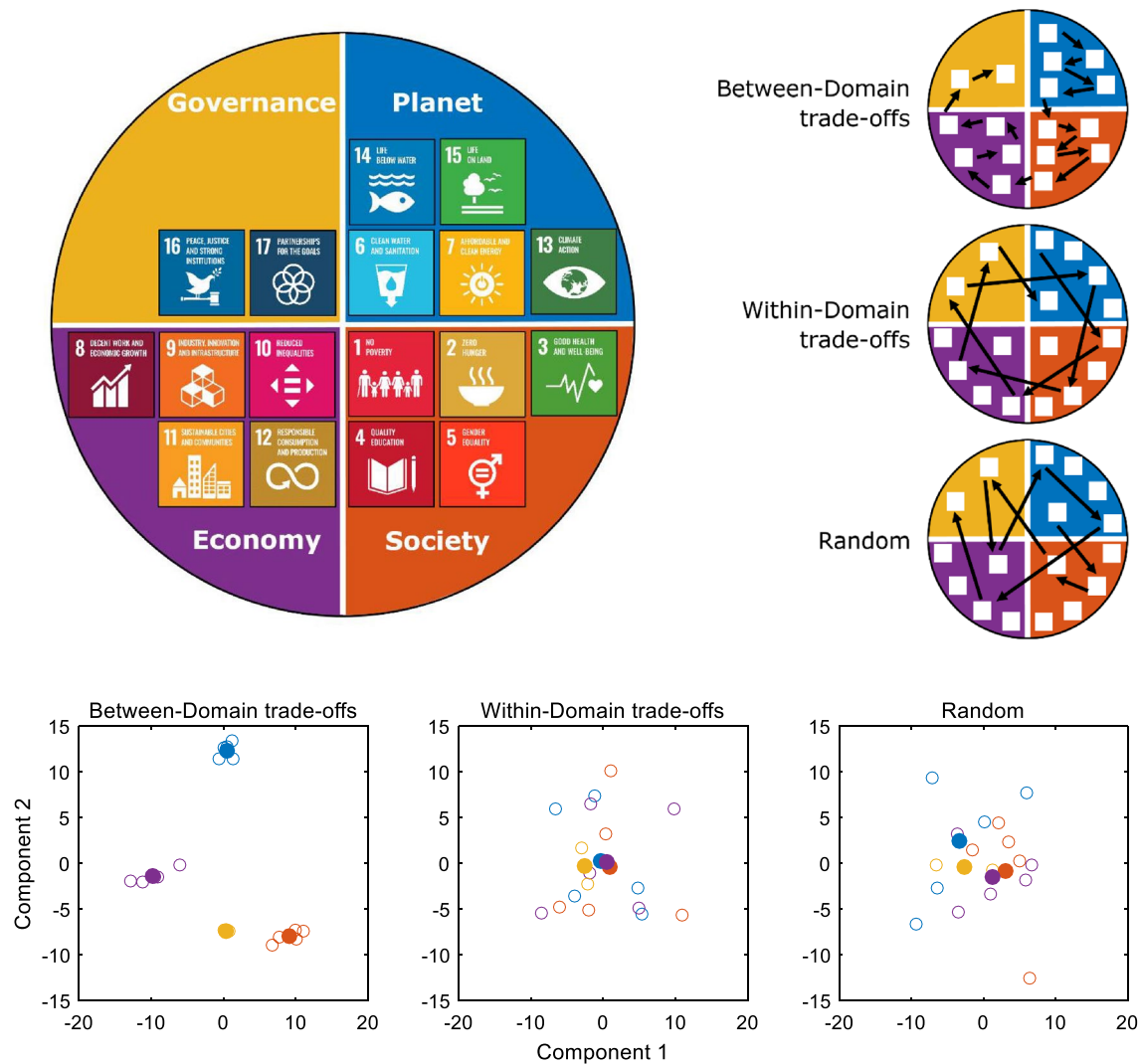


Fig. 3 Overview of the theoretical framework used in the study. The Sustainable Development Goals are considered to be embedded within four Sustainability Domains, following the framework presented in Muff et al. (2017). Theoretical simulations of Q-sorts were made, considering three scenarios: (i) Participants ranked Domains, therefore main trade-offs in importance occurring between Domains; (ii) Participants ranked SDGs selecting alternately from different Domains, so that trade-offs in importance occur within Domains; (iii) Participants select SDGs randomly. Arrows indicate the order

in which SDGs are selected; note that for the latter two scenarios, only the first eight choices are shown to maintain visibility. Note that boxes are left blank, as these were randomized within 10,000 replicate simulations performed for each scenario. Analyzing the three scenarios according to the Q methodology revealed that between-Domain trade-offs and within-Domain trade-offs are reflected in the positioning of SDG and Domain positions within the component space obtained

We found that the distribution of participants over the five clusters varied between the three SIS (Fig. 5, Multi-level Chi-squared test: $X^2_{2,4}=25.7, p=0.0012$). Specifically, the majority of participants from Suriname were part of the fifth cluster, while also forming the largest relative proportion of the first cluster (Fig. 5). In contrast, participants from Trinidad were underrepresented in both these clusters, while forming the largest relative proportion of the third cluster (Fig. 5). Participants from Aruba were even more strongly underrepresented in the fifth cluster, while clearly forming

the largest relative proportion of the second cluster (Fig. 5). Contrary to these differences between participants from the three SIS, we did not find significant differences in the gender distribution over the five clusters (Fig. 5, Multi-level Chi-squared test: $X^2_{1,4}=2.3, p=0.68$).

There were significant differences in the relative importance assigned to each SDG by members of the five clusters, with the exception of SDG 10 (Fig. 6). Large differences in average scores were observed for SDG 1 and SDG 2, partly explaining the difference in relative importance assigned to

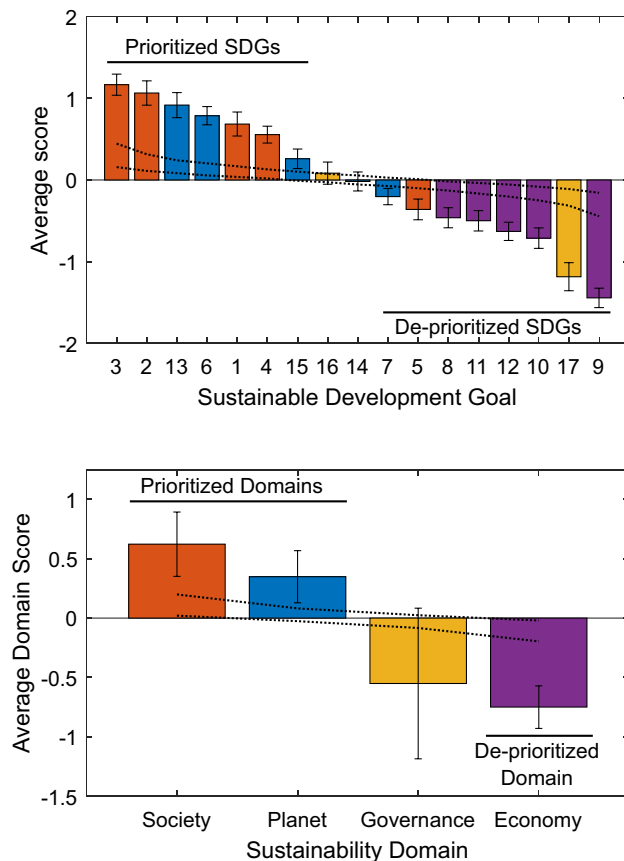


Fig. 4 Average scores of individual Sustainable Development Goals (SDGs, top panel) and Sustainability Domains (bottom panel), based on the Q Sorts of 108 participants from 3 Small Island States (SIS). Dotted lines indicate the 95% intervals of scores that were generated under the null hypothesis of random ranking of SDGs by participants (using 10,000 bootstrap replicates). Significant deviations from the null hypothesis are interpreted as the cases where the observed average scores (± 1 standard error) and the confidence interval do not overlap. Higher scores indicate prioritization of the SDG or Domain, whereas lower scores indicate de-prioritization of the SDG or Domain. In addition, the total variation in Domain averages as observed in the bottom panel was larger than occurred in any of the 10,000 bootstrap replicates (i.e. $p < 0.0001$)

the Society-related SDGs among the five clusters (Figs. 5, 6). Similarly, within the Planet-oriented SDGs, the largest differences in average scores were observed for SDGs 13, 14 and 15 (Fig. 6). We also found for all five clusters that the variation in average scores of SDGs within Sustainability Domains was significantly smaller than the average distance between the individual SDGs (Randomization tests, Group 1 as follows: $R_{\text{between/within}} = 3.27$, $p < 0.0001$; Group 2: $R_{\text{between/within}} = 1.54$, $p = 0.039$; Group 3: $R_{\text{between/within}} = 1.55$, $p = 0.038$; Group 4: $R_{\text{between/within}} = 1.62$, $p = 0.028$; Group 5: $R_{\text{between/within}} = 2.58$, $p = 0.0011$). This suggests that within each cluster identified, prioritization of the SDGs occurred to a significant extent at the Sustainability Domain level.

These trends, however, were inferred from cluster averages, which are still characterized by variation within these groups. Further information can thus be extracted by assessing the correlation structure among the individual participants' Q-sorts, as discussed in the next section.

Main trade-offs in prioritization occur between Sustainability Domains

The Q-sort analysis yielded two components that together explained 66% of the variation between the Q-sorts submitted by the 108 study participants (Fig. 7). The positions of the SDGs within this two-dimensional component space further corroborated the notion that goal prioritization that mainly occurred at the level of the Sustainability Domains (Fig. 7). Along the first component, the higher perceived importance of the Society-related SDGs traded off with lower perceived importance of the Economy- and Planet-related SDGs and even lower perceived importance of the Governance-related SDGs (Fig. 7). Along the second component, the higher perceived importance of the Planet-related SDGs, and to a slightly lesser extent the Society-related SDGs, traded off with a lower perceived importance of the Economy- and Governance-related SDGs, respectively (Fig. 7). Focusing on the SDGs that showed the largest change in rank order across the two components (with changes in score ≥ 2 , cf. Brown 1996), higher scores of SDGs 2, 3, 4, 8 and 9 were associated with lower scores on SDGs 13, 14 and 15, and vice versa (Fig. 7). Thus, the trade-offs described above are mainly expressed by the prioritization the Society-related SDGs 2, 3, 4 and the Economy-related SDGs 8, 9 on the one hand, and the Planet-related SDGs 13, 14, 15 on the other hand (Fig. 7). Interestingly, for SDGs within the Economy and Planet Domains, the relative ranking changed substantially between the two components (Fig. 7). In contrast, for the Society and Governance Domains, this relative ranking of SDGs was similar along the two components. It should be noted, however, that the Governance Domain only comprises two SDGs, meaning that there are only two ranking possibilities.

While the average Domain positions in the two-dimensional component space were broadly consistent among the three SIS considered (Figs. 7, 8), some differences in alignment with each component were also observed (Figs. 7, 8). More specifically, the Q-sorts of participants in Aruba aligned less well with the first component as compared to participants from Suriname and Trinidad (Fig. 8; One-way ANOVA, $F_{2,105} = 3.28$, $p = 0.0415$), although post-hoc testing showed that the difference between Aruba and Suriname was not statistically significant (Tukey HSD test: difference between

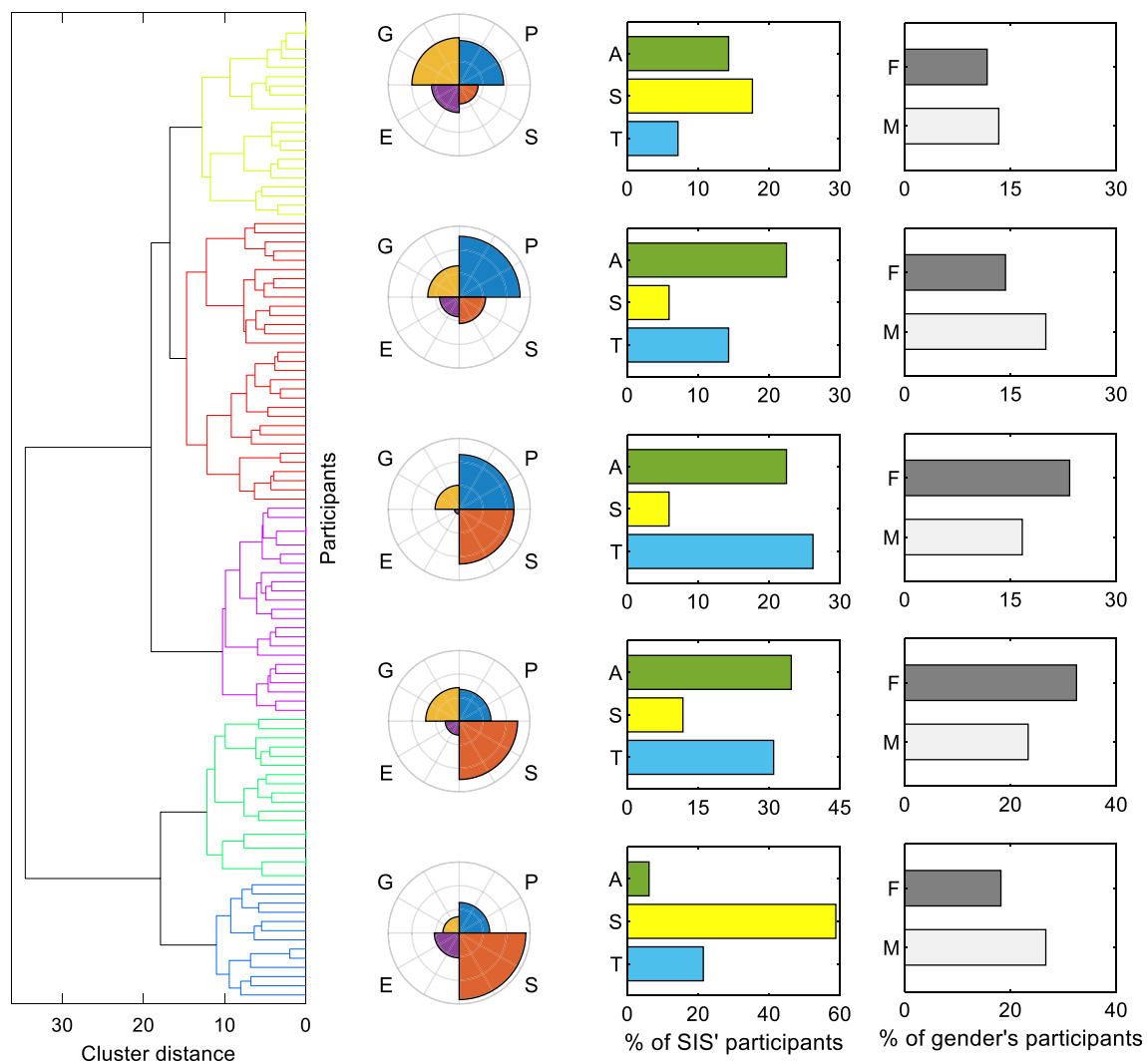


Fig. 5 Results of a cluster analysis identifying 5 groups of participants that differed in their perception of the relative importance of the SDGs. Clusters are indicated with different colors in the clustering tree. Average scores per domain are indicated for each cluster (P=Planet, S=Society, E=Economy, G=Governance). The relative

proportion of participants from each SIS in each cluster is indicated in the colored bar chart (A=Aruba, S=Suriname, T=Trinidad and Tobago). The relative proportion of participants per gender in each cluster is indicated in the grayscale bar chart (F=Female, M=Male)

means = 0.042, $p = 0.24$). Regarding the second component, the Q-sorts of participants in Suriname tended to be lower as compared to participants from Aruba and Trinidad (Fig. 8; One-way ANOVA, $F_{2,105} = 2.96$, $p = 0.0562$), a trend that was mainly driven by the difference between participants from Suriname and Aruba (Tukey HSD test: difference between means = 0.0557, $p = 0.0487$). In summary, the participant group from Aruba tended to prioritize SDGs within the Planet Domain over SDGs within the Economy and Society Domains, when compared to the prioritizations of participants from Suriname and Trinidad (Figs. 7, 8).

Discussion and Conclusion

University learners' ranking of the SDGs revealed different valuations of Sustainability Domains, operationalized as Economy, Governance, Planet and Society (Figs. 4, 5, 6, 7, 8). Cluster analysis revealed different views on which particular Sustainability Domains were most and least valued and showed that which view was most popular differed among the three SIS considered (Fig. 5). Looking at the correlation structure between the SDG rankings of all participants, a trade-off was observed between prioritizing Society-related and Economy-related SDGs at the expense

Fig. 6 Average scores on individual SDGs, for the participant clusters shown in Fig. 5. Bar colors correspond to the colors of the clustering tree in Fig. 5. The font colors of the SDGs indicate the different Sustainability Domains, using the same color scheme as in Fig. 3. Significant differences between average cluster group scores were observed for all SDGs, except SDG 10 (“Reduced inequalities”). Different letters indicate significant differences between cluster groups ($p < 0.05$, as determined with One-way ANOVA and Tukey-HSD posthoc tests)

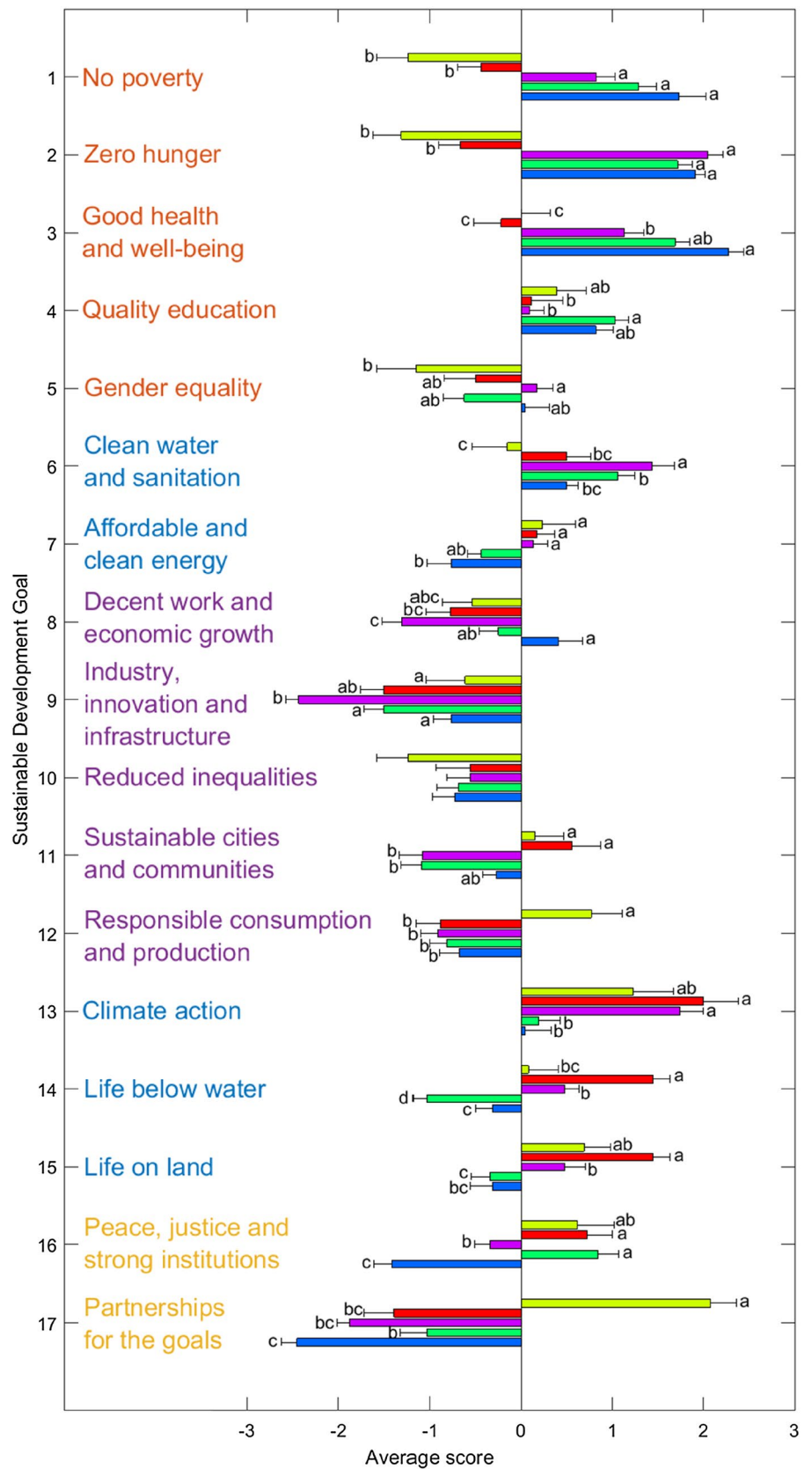
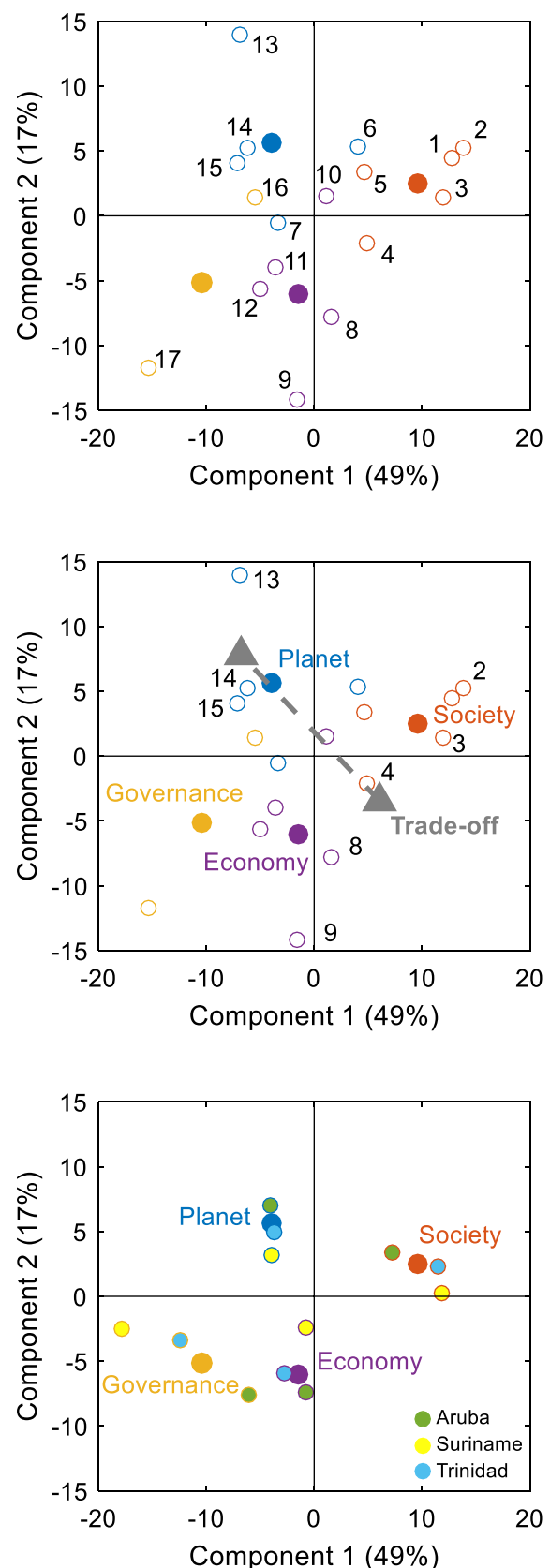


Fig. 7 Using the Q methodology, two (rotated) principal components were extracted, which together explained 66% of the variance between participants' ranking of the Sustainable Development Goals (SDGs). Top panel: Positions of the individual Sustainable Development Goals (SDGs) are indicated with numbers, showing that Society-related SDGs had high loadings on the first axis, while the Governance related-SDGs had low loadings on this axis. On the second axis, Planet-related SDGs had high values, while Economy-related SDGs had low values on this axis. Middle panel: A trade-off could be identified between the Planet-related SDGs 13, 14 and 15 on the one hand, and the Economy-related and Society-related SDGs 2, 3, 4, 8 and 9 on the other hand. Bottom panel: While the Domain positions were largely consistent between the three SIS participant groups, differences occurred between the relative alignment with the two axes. Where Suriname and Trinidad aligned better with the first component (i.e. larger variation between Domains as compared to the overall average positions), Aruba aligned better with the second component

of Planet-related SDGs, and vice versa (Fig. 7). The current study considered the potential of the SDGs as a communication tool in ESD, for which the SDGs are increasingly considered (Annan-Diab and Molinari 2017; Agirreazkuenaga 2019; Eppinga et al. 2020; Kopnina 2020a, b). As the SDGs were originally designed to mobilize simultaneous action across Sustainability Domains (Fukuda-Parr 2019), it is of interest to assess the extent to which young learners operationalize this notion when briefly introduced to and subsequently invited to rank the SDGs according to their own perception of relative importance (Fig. 1). Within the context of ESD in SIS, the exercise is also of practical relevance, given that capacity constraints may imply that prioritization may become a necessary component of policies implementing the 2030 Agenda for Sustainable Development (Allen et al. 2018; Forestier and Kim 2021). Specifically, we could envision two types of potential applications of our method in ESD programs in general, and in SIS in particular.

The first type of application is the use of the information obtained with the method to structure subsequent education activities related to the SDGs and sustainable development. Our observation that learners' goal prioritization mainly occurred at the level of the Sustainability Domains (Fig. 7) cautions that framing ESD within the context of the SDGs without emphasizing their fundamental, cross-domain interdependencies could encompass a risk to amplify pre-conceived notions about the relative importance of different Sustainability Domains, rather than inviting transformative thinking towards integrated solutions. While the latter expectation is admittedly ambitious, it would be interesting to explore potential approaches to emphasize the interdependencies between the SDGs in ESD learning plans. Such approaches could be informed by recent efforts to highlight SDG interdependencies for policy development.

Within the context of policy development, nexus approaches have been proposed as one way toward integration of the different Sustainability Domains (Boas et al. 2016; Bleischwitz et al. 2018; Liu et al. 2018). Prominently



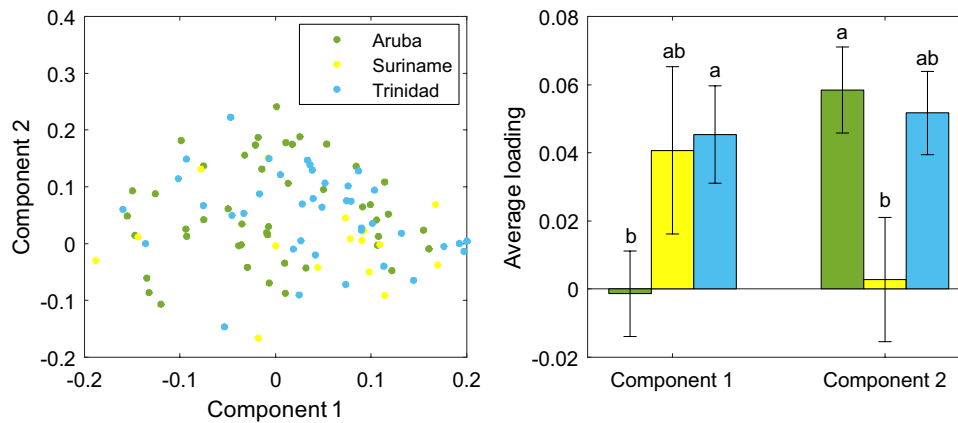


Fig. 8 Overview of the loadings of individual participants on the two components extracted with the Q methodology. Participants from the different SIS are indicated with different colors. Better alignment of participants from Suriname and Trinidad with the first component was reflected in a significantly lower average loading of participants

considered in this context is the food–water–energy nexus, as all three components of this nexus can affect and interact with all the SDGs (Liu et al. 2018). The integrative methods used within nexus approaches are particularly suited to reveal direct and indirect connections between the SDGs (Liu et al. 2018). Therefore, within ESD, highlighting such connections may enhance an understanding of the need for integrated SDG implementation. While nexus approaches can be applied to logistical supply chain networks such as those present in the food, water and energy sectors, they can also be applied to integrate policy frameworks related to the management of a particular type of ecosystem, for example (Timko et al. 2018). Another alternative that may enhance the development of promoting a holistic and integrated view on sustainable development is to consider the key interventions needed to reach the SDGs and organize these interventions into a limited set of Transformations (Sachs et al. 2019). Similar to the food–water–energy nexus, most of the six Transformations identified by Sachs et al. (2019) are linked to all the SDGs, thus providing a framework for highlighting the synergies and multiple dependencies between the SDGs across Domains. An alternatively proposed approach to sustainability transformations focuses on entry points to adjustments in the underlying systems (GSDR 2019; Messerli et al. 2019). Different levers can then coherently be deployed within each of these entry points to bring about the necessary transformations, going beyond addressing a single SDG or even a cluster of SDGs, taking into account synergies and trade-offs, and offering a more holistic approach instead (GSDR 2019).

While such thematic connections may clarify the inter-relatedness of the SDGs across Domains, their effectiveness will partly depend on the extent to which these themes

from Aruba on this component. In contrast, the Q-sorts from Aruban participants aligned significantly better with the second axis as compared to participants from Suriname. Different letters indicate significant differences ($p < 0.05$, as determined with One-way ANOVA and Tukey-HSD posthoc tests)

resonate within the local geographical and historical context (Mercer et al. 2012; Leotaud and Cadiz 2013; Eppinga et al. 2019; Fuldauer et al. 2019). Small Island States are faced with unique sets of sustainability challenges, which not only emphasize the need to recognize the interdependencies between the SDGs, but also the need for transformations that are compatible with the opportunities and constraints within the specific SIS considered (Leotaud and Cadiz 2013; Ballayram 2017; Brissett 2018). For example, transitioning toward a green economy was a theme that featured prominently in the discussions leading up to the formulation of the SDGs, with Seychelles emphasizing how the economies of SIS rely heavily on oceans—adjusting the concept towards the blue economy (Nhamo et al. 2020). Indeed, an analysis of the synergies and trade-offs between SDG 14 (Life below water) and the other SDGs revealed many synergies with SDGs 1–16, including robust synergies with SDGs 2, 3 and 8 (Singh et al. 2018). These latter synergies are of particular interest when considering the main trade-off observed in this study regarding SIS learners' perceptions of the relative importance of the SDGs (Fig. 7). Hence, introducing the concept of transitioning toward a blue economy in ESD in the SIS considered may be one example to highlight the need for an integrated approach to sustainable development in SIS. Yet, which interventions can promote trajectories toward a more sustainable system depends strongly on the current state of the social-ecological system considered (Eppinga et al. 2021). This also implies that trajectories toward more sustainable states may differ between SISs. For example, it is of interest to note that Aruba currently experiences high pressure on its natural environment (Table 1) and that the learners from Aruba considered Planet-related SDGs of high relative importance (Figs. 5, 7, 8). The concept of a

SIS-specific blue economy could then show potential synergies between Economy-related SDGs and Planet-related SDGs, where our findings suggest that the latter may provide an entry point to engage learners from Aruba in particular (Figs. 5, 7, 8). While the observed learner prioritizations of the SDGs could be linked to local sustainability challenges as inferred from state-level indicators (Table 1), an interesting avenue for further research would be to inquire learners directly about the perceived sustainability challenges of their SIS and compare these perceptions with their ranking of the SDGs.

This leads to a second type of application of the method, which could be the use of participants' initial ranking as a starting point for participant discussions about SDG prioritization within the context of their country of residence. The clustering method could be used to compose discussion groups that showed similar views (i.e. within the same cluster) or diverging views (i.e. with members from different clusters). Such participatory approaches may provide an effective component of ESD learning programs (Wang et al. 2018; Eppinga et al. 2019, 2020), while group composition could be varied in the degree of initial consensus (Öhman and Öhman 2013). This second type of application would also be interesting from an academic research perspective, as it would allow for incorporating the qualitative components of the Q methodology (Brown 1993; Barry and Proops 1999; Duenckmann 2010; Vaas et al. 2019; Ciftcioglu 2020). While the online application tool presented here (Fig. 1) provides an opportunity to collect Q-sorts from large numbers of participants at different locations on the globe simultaneously, it does not allow for obtaining deeper insights into participants' thinking as obtained in the qualitative steps of the Q methodology. In the context of our ranking exercise, it would be valuable to know the level of detail in which the participants are already familiar with the SDGs, especially with regard to SDG-specific targets and indicators. Moreover, ranking choices may be based on perceived dependencies, synergies and trade-offs between SDGs, or may involve considerations of feasibility, for example (Ward et al. 2016; Kumar et al. 2018; Nerini et al. 2017; Coenen et al. 2021; Skene 2021). In addition, it would be of interest to explore to what extent the Sustainability Domains identified in the academic literature (e.g. Costanza et al. 2016a, b; Folke et al. 2016; Muff et al. 2017; Dalampira and Nastis 2020; Kostoska and Kocarev 2019; Delli Paoli and Addeo 2019; Vinuesa et al. 2020) are recognized by young learners. From this type of qualitative information, the ranking exercise can be more explicitly linked to learners' perception of the need for integration across Sustainability Domains, and the efficacy of the SDGs to convey this notion. Another

avenue for further research is a more in-depth analysis of participants' interpretation of 'relative importance', i.e. the scale along which SDGs were ranked (Fig. 1). For example, by ranking one SDG as more important to another, a participant may not necessarily be meaning that the former SDG "deserves higher priority"; alternative interpretations, such as "is logically prior to" or "is a prerequisite for" would be possible as well. Furthermore, a participant may evaluate importance at different levels of societal organization, taking an individual, national or global perspective, for example. Interestingly, the differences observed between participants of the three SIS considered suggest that the national context may have played a role when evaluating importance, which would be of interest to study in more detail, using in-depth interviews for example. While these qualitative components of the Q methodology are typically applied in studies that involve a small number of participants (Brown 1993, 1996, 2005; Ellingsen et al. 2010), such results may prove insightful to interpreting quantitative results from larger samples.

ESD is critical to developing and enhancing the knowledge, values and attitudes, skills, and action competencies that allow citizens of SIS to take ownership of the 2030 Agenda for Sustainable Development and its SDGs (Ferguson 2020). The SDGs have been successful in communicating the 2030 Agenda and its global call for action. Hence, it is understandable that the SDGs are frequently used in ESD as an operationalization of the sustainable development concept (Annan-Diab and Molinari 2017; Agirreazkuenaga 2019; Eppinga et al. 2020; Kopnina 2020a, b). Our study provides a means to test whether this use of the SDGs in teaching directly conveys the intended message of the interconnectedness of sustainability challenges and the need for integrated approaches to realize the sustainability transition (Sachs et al. 2019). While our study suggests that the current organization of the SDGs may confirm pre-conceived notions about the relative importance of different Sustainability Domains, the presented method could also be used to identify key connections and synergies between SDGs not yet known to the ESD program participants. These connections could be highlighted in several ways, for example through discussion of nexus approaches (Liu et al. 2018), sustainability transformation frameworks (GSDR 2019; Messerli et al. 2019; Sachs et al. 2019), or by using a specific thematic lens (e.g. Singh et al. 2018). Providing an interactive online tool that can be utilized to explore these approaches, our study suggests promising avenues to further develop ESD that is specifically tailored to the local context. Such connections to the local context may be an important requisite for effective communication of pathways to address the unique sustainability challenges facing SIS and their inhabitants.

Appendix 1

In this Appendix, we describe the quantitative analyses of the study in more detail. We first explain the randomization test that was used to compare average scores of individual SDGs and Sustainability Domains. Subsequently, we describe the cluster analysis and the randomization test that was used to quantify the extent to which SDG prioritization within groups occurred at the Sustainability Domain level. Finally, we describe the quantitative steps involved in obtaining the correlation structure from the total set of participants' Q-sorts, and the details of the subsequent exploration of this structure using Principal Component (PCA) analysis.

Perceptions of the relative importance of individual SDGs and Sustainability Domains

For all the analyses described in this Appendix, the Q-grid's seven-point scale ranging from 'least important' to 'most important' was converted into a numerical scale, with scores ranging from -3 (least important) to $+3$ (most important). Due to the symmetric structure of the Q-grid (Fig. 1 of the main text), a participant's set of ranking scores, the Q-sort S , is centered around 0 (Brown 1996). As explained in the main text, comparisons of average scores needed to account for the specific constraints for the data structure as set by the Q-grid used for ranking the SDGs. We accounted for this by creating a null model prediction based on 10,000 bootstrap replicate simulations. In each bootstrap replicate simulation, the same number of Q-sorts as obtained in our study (i.e. $n = 108$) was randomly filled with the SDGs (without replacement). Hence, any variation in average scores between SDGs or between Sustainability Domains in these bootstrap replicates can be attributed to the constraints set by the Q-grid (see Fig. 1 in the main text) and the number of participants of the study. These simulated data then enabled us to calculate confidence intervals around each SDG and each Domain average. Hence, this randomization test could be used to identify whether observed average scores were significantly different from random. Using a conservative approach, we only considered scores significantly different from random if there was no overlap between the 95% confidence interval spanned by bootstrap replicates and the observed average ± 1 standard error (which is more conservative than only considering the observed average).

Identifying different views on prioritization of the SDGs

The goal of the cluster analysis was to identify 3–5 groups of participants. This was the target range, to ensure that

the number of participants within each cluster was large enough to reliably characterize average scores, yet small enough to capture multiple differences between multiple groups. The input data for the cluster analysis were the 108 Q-sorts described above (S_j , with $j = 1, 2, \dots, 108$). The individual Q-sorts formed the starting point of the clustering tree. This starting point is shown on the right-hand side of the clustering tree in Fig. 5 of the main text, at the x -coordinate Cluster Distance = 0. The clustering algorithm then identifies which two clusters in the dataset are most similar to each other, i.e., that are separated by the shortest cluster distance. Then, these two clusters are combined into a larger cluster. Here, we used Ward's inner-squared distance algorithm to calculate distances between clusters, selecting this criterion within the 'linkage' function that is part of MATLAB's Statistics and Machine Learning toolbox. This clustering process can continue until all 108 initial clusters are combined into a single cluster. We selected the optimal number of clusters from our target range using the silhouette statistic, which quantifies the difference between the average within-cluster distance and the average distance to the nearest neighboring cluster (Kaufman and Rousseeuw 1990). Specifically, we used this criterion within the 'evalclusters' function that is part of MATLAB's Statistics and Machine Learning toolbox. Using this procedure, we found that the clustering into five groups comprised the optimal number within the target range considered.

After the clusters were obtained, we could calculate for each of the five clusters the extent to which SDGs were ranked according to the Sustainability Domains. Specifically, we calculated the variance in average scores within clusters and the variance in average scores between all SDGs as follows:

$$R_{\text{between/within}} = \frac{\frac{2}{N(N-1)} \sum_{i \neq j}^N (S_i - S_j)^2}{\frac{1}{D} \sum_{d=1}^D \frac{1}{n} \sum_{i \neq j}^n (S_{d,i} - S_{d,j})^2}, \quad (1)$$

where N is the number of SDGs and D is the number of domains. Equation (1) shows that values of $R_{\text{between/within}}$ larger than 1 indicate that the variance of scores between all SDGs is larger than the variance within Domains, thus indicating a Domain-level effect in the prioritization of the SDGs by the participants assigned to that particular cluster. To assess whether observed values of $R_{\text{between/within}}$ were significantly larger than one, we create for each of the five clusters a null model prediction, using a partition testing approach with 10,000 replicates (e.g. Stone et al. 2000; Sanders et al. 2003). For each replicate, we randomized the labels of the SDGs (i.e. randomize the numbers 1 to 17) and then calculated $R_{\text{between/within}}$ using Eq. 1. This yielded a null model prediction in the form of a distribution of $R_{\text{between/within}}$ values calculated under the null hypothesis of

no Domain-level effects on the average scores of the SDGs within each cluster. We note that the null model prediction, based on the absence of Domain-level effects, is generated under the same constraints as the observational data and, therefore, provides a robust comparative framework to test for the presence of Domain-level effects in the observational data. Probabilities of exceedance were then determined non-parametrically as the proportion of bootstrap replicates exceeding the value of $R_{\text{between/within}}$ as calculated from the observed data (e.g. Eppinga et al. 2010).

Identifying the main axes of variation in participants' prioritization of SDGs

Similar to the previous analysis, the input data for this analysis were provided by the Q-sorts S , with scores ranging from -3 to $+3$, and a mean value of 0. We note that the Q-grid also standardizes the variance, V , within a participant's set of ranking scores (Brown 1996). For the specific structure of the Q-grid used in this study, the variance in each participant's Q-sort is as follows:

$$V = \sum_{i=1}^{17} S_i^2 = 40, \quad (2)$$

where S_i indicates the score assigned to the i^{th} SDG. The first data processing step in the Q method is then to create a correlation matrix, C , that quantifies the degree of correlation between the Q-sorts of each pair of participants that can be formed from the dataset (a total of $\frac{n(n-1)}{2}$ pairs, with $n=108$, this meant 5778 participant pairs for the current study). Specifically, the correlation between participant j and participant k is calculated as (Brown 1996) follows:

$$C_{jk} = 1 - \frac{\sum_{i=1}^{17} (S_{j,i} - S_{k,i})^2}{2V} = 1 - \frac{\sum_{i=1}^{17} (S_{j,i} - S_{k,i})^2}{80}, \quad (3)$$

in which $S_{j,i}$ indicates the score that participant j assigned to the i^{th} SDG. The second step in the Q method is then to utilize the correlation matrix C to identify the major axes of variation between participants' Q-sorts (Brown 1996). Both Factor Extraction (FE) and Principal Component Analysis (PCA) are common methods used to identify the major axes of variation within this step of the Q methodology (Akhtar-Danesh 2017). In the third step, the obtained factors or principal components are rotated to reveal patterns of interest more clearly, and to ease interpretation of the results (Brown 1993, 1996, 2005; Akhtar-Danesh 2017). In this study, we used PCA, followed by quartimax rotation on the principal components obtained (Akhtar-Danesh 2017). These analyses were carried with the 'pca' and 'rotatefactors' functions, which are part of MATLAB's Machine Learning and Statistics Toolbox.

Performing a PCA on the correlation matrix C yields components that consist of loadings for each participant. In the fourth step of the Q method, the loadings on the (rotated) components are converted into weights, that is, the contribution of each participant to the specific PCA component considered as follows:

$$w_{jl} = \frac{f_{jl}}{1 - f_{jl}^2} \quad (4)$$

In which w_{jl} and f_{jl} are the weight and the loading of participant j on the (rotated) principal component l , respectively. As a fifth step in the Q method, each (rotated) component can be transformed back into a characteristic Q-sort, in this case a specific ranking of the 17 SDGs. The idea is that the contribution of a participant's Q-sort to the calculation of a component's characteristic Q-sort depends on the participant's weight on that component: the higher the weight of the participant, the more the component's characteristic Q-sort will be like the Q-sort submitted by that participant. The position of each SDG within the component Q-sort is then given by its weighted average of all participant scores as follows:

$$T_{i,l} = \sum_{j=1}^{108} w_{jl} S_{j,i} \quad (5)$$

In which $T_{i,l}$ is the total score of the i^{th} SDG on the (rotated) principal component l . Finally, the values of $T_{i,l}$ are then used to fill the Q-grid, with the SDG with the largest value of $T_{i,l}$ filling the 'most important' (+3) category, the SDGs with the second and third largest value of $T_{i,l}$ filling the next (+2) category, etc. Hence, this procedure yields a characteristic Q-sort for each of the (rotated) components obtained (Brown 1993).

In the main text, we also compared the average weights on the first two (rotated) PCA components for the learner groups of the three SIS included in this study. Differences were tested with One-Way ANOVA and a post-hoc Tukey HSD test. This parametric procedure could be used, as weights were normally distributed (verified with Jarque–Bera tests: Aruba: $J_{\text{Component1}} = 1.23$, $p = 0.42$, $J_{\text{Component2}} = 1.93$, $p = 0.23$; Suriname: $J_{\text{Component1}} = 2.38$, $p = 0.09$, $J_{\text{Component2}} = 0.24$, $p = 0.50$; Trinidad: $J_{\text{Component1}} = 0.39$, $p = 0.50$, $J_{\text{Component2}} = 0.02$, $p = 0.50$), and there was homoscedasticity of variances between groups (verified with Levene tests: Component 1: $W_{2,105} = 0.26$, $p = 0.77$; Component 2: $W_{2,105} = 1.53$, $p = 0.22$).

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11625-022-01100-7>.

Acknowledgements This study was supported/funded by the University Research Priority Program on Global Change and Biodiversity of the University of Zurich. The authors would like to thank Dr. Kathryn Chan, Dr. Riad Nurmohamed and Dr. Henry Ori for their help in collecting the survey data. The authors would also like to thank Dr. Jetske Vaas for the introduction to and further discussions about the Q methodology, and two anonymous reviewers for comments that improved the manuscript.

Funding Open access funding provided by University of Zurich.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Agirreazkuenaga L (2019) Embedding Sustainable Development Goals in education. Teachers' perspective about education for sustainability in the Basque Autonomous Community. *Sustainability* 11:1496
- Akhtar-Danesh N (2017) A comparison between major factor extraction and factor rotation techniques in Q-methodology. *Open J Appl Sci* 7:147–156
- Allen C, Metternicht G, Wiedmann T (2018) Initial progress in implementing the Sustainable Development Goals (SDGs): a review of evidence from countries. *Sustain Sci* 13:1453–1467
- Annan-Diab F, Molinari C (2017) Interdisciplinarity: practical approach to advancing education for sustainability and for the Sustainable Development Goals. *Int J Manag Educ* 15:73–83
- Ballayram T (2017) The promises and challenges of the Sustainable Development Goals for CARICOM Caribbean countries. *J Food Secur* 5:1–8
- Barry J, Proops J (1999) Seeking sustainability discourses with Q methodology. *Ecol Econ* 28:337–345
- Biermann F, Kanie N, Kim RE (2017) Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals. *Curr Opin Environ Sustain* 26–27:26–31
- Bleischwitz R, Spataru C, VanDeveer SD, Obersteiner M, van der Voet E, Johnson C, Andrews-Speed P, Boersma T, Hoff H, van Vuuren DP (2018) Resource nexus perspectives towards the United Nations Sustainable Development Goals. *Nat Sustain* 1:737–743
- Boas I, Biermann F, Kanie N (2016) Cross-sectoral strategies in global sustainability governance: towards a nexus approach. *Int Environ Agreem: Politics Law Econ* 16:449–464
- Briguglio L (2014) A vulnerability and resilience framework for small states. In: Bynoe DL (ed) *Building the resilience of small states—a revised framework*. Commonwealth Secretariat, London, pp 10–76
- Brissett NOM (2018) Sustainable Development Goals (SDGs) and the Caribbean: unrealizable promises? *Prog Dev Stud* 18:18–35
- Brown SR (1993) A primer on Q methodology. *Operant Subj* 16:91–138
- Brown SR (1996) Q methodology and qualitative research. *Qual Health Res* 6:561–567
- Brown SR (2005) Applying Q methodology to empowerment. In: Narayan (ed) *Measurement and empowerment: cross-disciplinary perspectives*, World Bank, Washington DC, pp 197–215
- Brown BJ, Hanson ME, Liverman DM, Merideth RW (1987) Global sustainability: toward definition. *Environ Manage* 11:713–719
- Brundtland Commission (1987) *Our Common Future* (The Brundtland Report). World Council on Sustainable Development, Oxford
- Caradonna JL (2017) An incompatible couple: a critical history of economic growth and sustainable development. In: Borowy I, Schmelzer M (eds) *History of the future of economic growth: historical roots of current debates on sustainable degrowth*. Routledge, London, pp 154–173
- Chin A, Jacobsson T (2016) TheGoals.org: mobile global education on the sustainable development goals. *J Clean Prod* 123:227–229
- Ciftcioglu GC (2020) Using a combination of Q-methodology and survey-based approach for assessing forest ecosystem services of Five Finger Mountains in Northern Cyprus. *Sustain Sci* 15:1789–1805
- Coenen J, Glass L-M, Sanderink L (2021) Two degrees and the SDGs: a network analysis of the interlinkages between transnational climate actions and the Sustainable Development Goals. *Sustain Sci*. <https://doi.org/10.1007/s11625-021-01007-9>
- Connell J (2018) Islands: balancing development and sustainability? *Environ Conserv* 45:111–124
- Coogan J, Herrington N (2011) Q methodology: an overview. *Res Second Teach Educ* 1:24–28
- Costanza R, Daly L, Fioramonti L, Giovannini E, Kubiszewski I, Fogh Mortensen L, Pickett KE, Vala Ragnarsdottir K, De Vogli R, Wilkinson R (2016a) Modelling and measuring sustainable wellbeing in connection with the UN Sustainable Development Goals. *Ecol Econ* 130:350–355
- Costanza R, Fioramonti L, Kubiszewski I (2016b) The UN Sustainable Development Goals and the dynamics of human well-being. *Front Ecol Env* 14:59
- Cottafava D, Cavaglià G, Corazza L (2019) Education of sustainable development goals through students' active engagement: a transformative learning experience. *Sustain Account Manag Policy J* 10:521–544
- Cross RM (2005) Exploring attitudes: the case for Q methodology. *Health Educ Res* 20:206–213
- Curry R, Barry J, McClenaghan A (2013) Northern Visions? Applying Q methodology to understand stakeholder views on the environmental and resource dimensions of sustainability. *J Environ Plann Manage* 56:624–649
- Dalampira E-S, Nastis SA (2020) Mapping Sustainable Development Goals: a network analysis framework. *Sust Dev* 28:46–55
- De Scisciolo T, Mijts EN, Becker T, Eppinga MB (2016) Beach debris on Aruba, Southern Caribbean: attribution to local land-based and distal marine-based sources. *Mar Pollut Bull* 106:49–57
- DeLind LB, Link T (2004) Place as the nexus of a sustainable future: a course for all of US. In: Barlett PF, Chase GW (eds) *Sustainability on campus: stories and strategies for change*. MIT Press, Cambridge, pp 121–137
- Delli Paoli A, Addeo F (2019) Assessing SDGs: a methodology to measure sustainability. *Athens J Soc Sci* 6:229–250
- Di Baldassarre G, Sivapalan M, Rusca M, Cudennec C, Garcia M, Kreibich H, Konar M, Mondino E, Mård J, Pande S, Sander MR, Tian F, Viglione A, Wei J, Wei Y, Yu DJ, Srinivasan V, Blöschl G (2019) Sociohydrology: scientific challenges in addressing the sustainable development goals. *Water Resour Res* 55:6327–6355
- Dora C, Haines A, Balbus J, Fletcher E, Adair-Rohani H, Alabaster G, Hossain R, de Onis M, Branca F, Neira M (2015) Indicators

- linking health and sustainability in the post-2015 development agenda. *Lancet* 385:380–391
- Duenckmann F (2010) The village in the mind: Applying Q-methodology to reconstructing constructions of rurality. *J Rural Studies* 26:284–295
- Ellingsen IT, Størksen I, Stephens P (2010) Q methodology in social work research. *Int J Soc Res Methodol* 13:395–409
- Eppinga MB, Pucko CA (2018) The impact of hurricanes Irma and Maria on the forest ecosystems of Saba and St. Eustatius, northern Caribbean. *Biotropica* 50:723–728
- Eppinga MB, Rietkerk M, Belyea LR, Nilsson MB, de Ruiter PC, Wasen MJ (2010) Resource contrast in patterned peatlands increases along a climatic gradient. *Ecology* 91:2344–2355
- Eppinga MB, De Scisciolo T, Mijts EN (2019) Environmental science education in a small island state: integrating theory and local experience. *Environ Educ Res* 25:1004–1018
- Eppinga MB, Lozano-Cosme J, De Scisciolo T, Arens P, Santos MJ, Mijts EN (2020) Putting sustainability research into practice on the university campus: an example from a Caribbean small island state. *Int J Sustain High Educ* 21:54–75
- Eppinga MB, Siteur K, Baudena M, Reader MO, van't Veen H, Anderies JM, Santos MJ (2021) Long-term transients help explain regime shifts in consumer-renewable resource systems. *Commun Earth Environ* 2:42
- Ferguson T (2020) Environmental and sustainability education in the Caribbean: crucial issues, critical imperatives. *Environ Educ Res* 26:763–771
- Folke C, Biggs R, Norström AV, Reyers B, Rockström J (2016) Social-ecological resilience and biosphere-based sustainability science. *Ecol Soc* 21:41
- Forestier O, Kim RE (2021) Cherry-picking the Sustainable Development Goals: goal prioritization by national governments and implications for global governance. *Sustain Dev* 28:1269–1278
- Fukuda-Parr S (2019) Keeping out extreme inequality from the SDG agenda—the politics of indicators. *Global Pol* 10:61–69
- Fuldauer LI, Ives MC, Adshead D, Thacker S, Hall JW (2019) Participatory planning of the future of waste management in small island developing states to deliver on the Sustainable Development Goals. *J Clean Prod* 223:147–162
- Girvan N (2005) Reinterpreting the Caribbean. In: Pantin D (ed) *The Caribbean economy: a reader*. Ian Randle Publishers, Kingston, pp 304–318
- Griggs D, Stafford-Smith M, Gaffney O, Rockström J, Öhman MC, Shyamsundar P, Steffen W, Glaser G, Kanie N, Noble I (2013) Sustainable development goals for people and planet. *Nature* 495:305–307
- GSDR (2019) *Global Sustainable Development Report 2019: The Future is Now—Science for Achieving Sustainable Development*. Independent Group of Scientists appointed by the Secretary-General, United Nations
- Guerra A (2017) Integration of sustainability in engineering education: why is PBL an answer? *Int J Sustain High Educ* 18:436–454
- Hák T, Janoušková S, Moldan B (2016) Sustainable Development Goals: a need for relevant indicators. *Ecol Indic* 60:565–573
- Hay JE (2013) Small island developing states: coastal systems, global change and sustainability. *Sustain Sci* 8:309–326
- Ho GWK (2017) Examining perceptions and attitudes: a review of Likert-type scales versus Q-methodology. *West J Nurs Res* 39:674–689
- Holden E, Linnerud K, Banister D (2017) The imperatives of sustainable development. *Sustain Dev* 25:213–226
- Horn P, Grugel J (2018) The SDGs in middle-income countries: setting or serving domestic development agendas? Evidence from Ecuador. *World Dev* 109:73–84
- IGDS (2021) *Welcome to the Institute for Gender and Development Studies*. University of the West Indies, St. Augustine campus. St. Augustine, Republic of Trinidad & Tobago. Available on the World Wide Web: <https://sta.uwi.edu/igds/>. Accessed 25 Mar 2021.
- International Council for Science (ICSU) and International Social Science Council (ISSC) (2015) *Review of the sustainable development goals: The science perspective*. ICSU, Paris
- Iofrida N, De Luca AI, Gulisano G, Strano A (2018) An application of Q-methodology to Mediterranean olive production—stakeholders' understanding of sustainability issues. *Agric Syst* 162:46–55
- Kaufman L, Rousseeuw P (1990) *Finding groups in data: an introduction to cluster analysis*. Wiley, New York
- Khoshnava SM, Rostami R, Zin RM, Štreimikienė D, Yousefpour A, Strielkowski W, Mardani A (2019) Aligning the criteria of Green Economy (GE) and Sustainable Development Goals (SDGs) to implement sustainable development. *Sustainability* 11:4615
- Kopnina H (2020a) Education for the future? Critical evaluation of education for Sustainable Development Goals. *J Environ Educ* 51:280–291
- Kopnina H (2020b) Education Sustainable Development Goals (ESDG): what is wrong with ESDGs, and what can we do better? *Educ Sci* 10:261
- Kostoska O, Kocarev L (2019) A novel ICT framework for Sustainable Development Goals. *Sustainability* 11:1961
- Kumar P, Ahmed F, Kumar Singh R, Sinha P (2018) Determination of hierarchical relationships among sustainable development goals using interpretive structural modeling. *Environ Dev Sustain* 20:2119–2137
- Le Blanc D (2015) Towards integration at last? The Sustainable Development Goals as a network of targets. *Sustain Dev* 23:176–187
- Leotaud N, Cadiz A (2013) Caribbean Small Island Developing States (SIDS): a civil society perspective on priorities for sustainable development. *Carib J Int Rel* 1:61–74
- Liu J, Hull V, Godfray CJ, Tilman D, Gleick P, Hoff H, Pahl-Wostl C, Xu Z, Chung MG, Sun J, Li S (2018) Nexus approaches to global sustainable development. *Nat Sustain* 1:466–476
- Lozano R, Merrill M, Sammalisto K, Ceulemans K, Lozano FJ (2017) Connecting competences and pedagogical approaches for sustainable development in higher education: a literature review and framework proposal. *Sustainability* 9:1889
- Lozano R, Barreiro-Gen M, Lozano FJ, Sammalisto K (2019) Teaching sustainability in European higher education institutions: assessing the connections between competences and pedagogical approaches. *Sustainability* 11:1602
- Manera C, Valle E (2018) Tourist intensity in the world, 1995–2015: two measurement proposals. *Sustainability* 10:4546
- Martin IM, Steelman TA (2004) Using multiple methods to understand agency values and objectives: lessons for public lands management. *Policy Sci* 37:37–69
- Meadows DH, Meadows DL, Randers J, Behrens WW (1972) *The limits to growth*. Universe Books, New York
- Mercer J, Kelman I, Alfthan B, Kurvits T (2012) Ecosystem-based adaptation to climate change in Caribbean Small Island Developing States: integrating local and external knowledge. *Sustainability* 4:1908–1932
- Messlerli P, Kim EM, Lutz W, Moatti J-P, Richardson K, Saidam M, Smith D, Eloundou-Enyegue P, Foli E, Glassman A, Hernandez Licona G, Murniningtyas E, Stanišis JK, van Ypersele J-P, Furman E (2019) Expansion of sustainability science needed for the SDGs. *Nat Sustain* 2:892–894
- Miola A, Borchhardt S, Neher F, Buscaglia D (2019) Interlinkages and policy coherence for the Sustainable Development Goals implementation: an operational method to identify trade-offs and co-benefits in a systemic way. Publications Office of the European Union, Luxembourg

- Moore J (2005) Seven recommendations for creating sustainability education at the university level: a guide for change agents. *Int J Sustain High Educ* 6:326–339
- Muff K, Kapalka A, Dyllick T (2017) The Gap Frame – translating the SDGs into relevant national grand challenges for strategic business opportunities. *Int J Manag Educ* 15:363–383
- Nerini FF, Tomei J, To LS, Bisaga I, Parikh P, Black M, Borrión A, Spataru C, Castán Broto V, Anandarajah G, Milligan B, Mulugetta Y (2017) Mapping synergies and trade-offs between energy and the Sustainable Development Goals. *Nat Energy* 3:10–15
- Nhamo G, Dube K, Chikodzi D (2020) Sustainable Development Goals : concept and challenges of global development goal setting. In: Haring R, Kickbusch I, Ganten D, Moeti M (eds) *Handbook of Global Health*. Springer International Publishing, Cham, pp 1–40
- Nilsson M, Griggs D, Visbeck M (2016) Policy: map the interactions between Sustainable Development Goals. *Nature* 534:320–322
- NIMOS (2013) Republic of Suriname National Report in preparation of the third international conference on Small Island Developing States. Ministry of Foreign Affairs and National Institute for Environment and Development in Suriname (NIMOS), Paramaribo
- Nunes AR, Lee K, O’Riordan T (2016) The importance of an integrating framework for achieving the Sustainable Development Goals: the example of health and well-being. *BMJ Glob Health* 1:e000068
- Nurmohamed R, Toelsie JR, Vervoort A, de Wulf R (2008) Master education and research program on sustainable management of natural resources in Suriname. In: *Proceedings of the 16th CAS Biennial Conference on Science and Technology: vehicles for sustainable economic development*, Grande Anse, Grenada, pp 234–239
- Öhman J, Öhman M (2013) Participatory approach in practice: an analysis of student discussions about climate change. *Environ Educ Res* 19:324–341
- Pham-Truffert M, Metz F, Fischer M, Rueff H, Messerli P (2020) Interactions among Sustainable Development Goals: knowledge for identifying multipliers and virtuous cycles. *Sustain Dev* 28:1236–1250
- Pradhan P (2019) Antagonists to meeting the 2030 Agenda. *Nat Sustain* 2:171–172
- Reyers B, Selig ER (2020) Global targets that reveal the social-ecological interdependencies of sustainable development. *Nat Ecol Evol* 4:1011–1019
- Robinson D, Newman SP, Stead SM (2019) Community perceptions link environmental decline to reduced support for tourism development in small island states: a case study in the Turks and Caicos Islands. *Mar Policy* 108:103671
- Sachs JD (2012) From Millennium Development Goals to Sustainable Development Goals. *Lancet* 379:2206–2221
- Sachs JD, Schmidt-Traub G, Mazzucato M, Messner D, Nakicenovic N, Rockström J (2019) Six Transformations to achieve the Sustainable Development Goals. *Nat Sustain* 2:805–814
- Sanders NJ, Gotelli NJ, Heller NE, Gordon DM (2003) Community disassembly by an invasive species. *Proc Natl Acad Sci USA* 100:2474–2477
- Scharlemann JP, Brock RC, Balfour N, Brown C, Burgess ND, Guth MK, Ingram DJ, Lane R, Martin JGC, Wicander S, Kapos V (2020) Towards understanding interactions between Sustainable Development Goals: the role of environment–human linkages. *Sustain Sci* 15:1573–1584
- Seccatore J, de Theije M (2017) Socio-technical study of small-scale gold mining in Suriname. *J Clean Prod* 144:107–119
- Shah KU, Rivera JE (2007) Export processing zones and corporate environmental performance in emerging economies: The case of the oil, gas, and chemical sectors of Trinidad and Tobago. *Policy Sci* 40:265–285
- Shorrocks A, Davies J, Lluberas R (2019) *Global Wealth Report 2019*. Credit Suisse Research Institute, Zürich
- Silvius AJG, Kampinga M, Paniagua S, Mooi H (2017) Considering sustainability in project management decision making: an investigation using Q-methodology. *Int J Project Manage* 35:1133–1150
- Singh GG, Cisneros-Montemayor AM, Swartz W, Cheung W, Guy JA, Kenny T-A, McOwen CJ, Asch R, Geffert JL, Wabnitz CCC, Sumaila R, Hanich Q, Ota Y (2018) A rapid assessment of co-benefits and trade-offs among sustainable development goals. *Mar Policy* 93:223–231
- Skene MR (2021) No goal is an island: the implications of systems theory for the Sustainable Development Goals. *Environ Dev Sustain* 23:9993–10012
- Sloan S, Jenkins CN, Joppa LN, Gaveau DLA, Laurance WF (2014) Remaining natural vegetation in the global biodiversity hotspots. *Biol Conserv* 177:12–24
- Stephenson W (1935) Technique of factor analysis. *Nature* 136:297
- Stephenson W (1982) Q-methodology, interbehavioral psychology, and quantum theory. *Psychol Rec* 32:235–248
- Sterling S (2016) A commentary on education and Sustainable Development Goals. *J Educ Sustain Dev* 10:208–213
- Stone L, Dayan T, Simberloff D (2000) On desert rodents, favored states, and unresolved issues: scaling up and down regional assemblages and local communities. *Am Nat* 156:322–328
- Taglioni F, Cruse R (2013) Is Suriname a Caribbean island like the others? In: Cruse R, Rhiney K (eds) *Caribbean Atlas*. Available on the World Wide Web: <http://www.caribbean-atlas.com/en/themes/is-suriname-a-caribbean-island-like-the-others.html>. Accessed 25 Mar 2021
- Teelucksingh S, Nunes PALD, Perrings C (2013) Biodiversity-based development in Small Island Developing States. *Environ Dev Econ* 18:381–391
- ten Klooster PM, Visser M, de Jong MDT (2008) Comparing two image research instruments: the Q-sort method versus the Likert attitude questionnaire. *Food Qual Prefer* 19:511–518
- Timko J, Le Billon P, Zerriffi H, Honey-Rosés J, de la Roche I, Gaston C, Kozak RA (2018) A policy nexus approach to forests and the SDGs: tradeoffs and synergies. *Curr Opin Environ Sustain* 34:7–12
- UNCED (1992) Agenda 21- program of action for sustainable development: Rio declaration on environment and development. United Nations Conference on Environment and Development (UNCED), Rio de Janeiro. United Nations, New York
- United Nations (1995) Report of the World Summit for Social Development. Copenhagen 6–12 March 1995. United Nations, New York
- United Nations (2015) Transforming our world: the 2030 agenda for sustainable development. Resolution adopted by the General Assembly on 25 September 2015, A/RES/70/1. UN General Assembly, New York
- Vaas J, Driessen PPI, Giezen M, Van Laerhoven F, Wassen MJ (2019) “Let me tell you your problems”. Using Q methodology to elicit latent problem perceptions about invasive alien species. *Geoforum* 99:120–131
- Van Beynen P, Akiwumi FA, Van Beynen K (2018) A sustainability index for small island developing states. *Int J Sustain Dev World Ecol* 25:99–116
- Veldhuizen-Doelahasori R (2011) Master Education and Research for Sustainable Development (MERSD)—the making of a Master programme. *Carib J Educ Sustain Dev* 1:23–28
- Vinuesa R, Azizpour H, Leite I, Balaam M, Dignum V, Domisch S, Felländer A, Langhans SD, Tegmark M, Nerini FF (2020) The role of artificial intelligence in achieving the Sustainable Development Goals. *Nat Commun* 11:233

- Wang X, Xu W, Guo L (2018) The status quo and ways of STEAM education promoting China's future social sustainable development. *Sustainability* 10:4417
- Ward JD, Sutton PC, Werner AD, Costanza R, Mohr SH, Simmons CT (2016) Is decoupling GDP growth from environmental impact possible? *PLoS ONE* 11:e0164733
- Watts S, Stenner P (2005) Doing Q methodology: theory, method and interpretation. *Qual Res Psychol* 2:67–91
- Wiek A, Bernstein M, Foley R, Cohen M, Forrest N, Kuzdas C, Kay B, Withycombe Keeler L (2015) Operationalising competencies in higher education for sustainable development. In: Barth M, Michelsen G, Rieckmann M, Thomas I (eds) *Handbook of higher education for sustainable development*. Routledge, London, pp 241–260
- World Bank (2018) *World Bank Annual Report 2018*. World Bank, Washington DC
- Yang L, Cormican K (2021) The crossovers and connectivity between systems engineering and the Sustainable Development Goals: a scoping study. *Sustainability* 13:3176
- Yeun EJ (2021) Q-methodology: understanding and applying it to nursing and health research. *Nurs Health Sci* (**in press**)
- Zabala A, Sandbrook C, Mukherjee N (2018) When and how to use Q methodology to understand perspectives in conservation research. *Conserv Biol* 32:1185–1194

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.