UNIVERSITY OF LEEDS

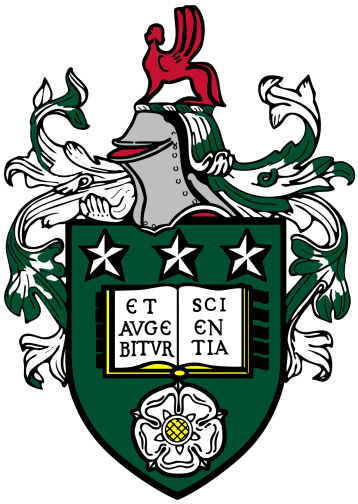
LAIDLAW FOUNDATION

A GLOBAL CAPSTONE EXPERIENCE: DEVELOPING AND PROMOTING GLOBAL CULTURAL AWARENESS AND EDUCATIONAL OPPORTUNITIES

DISCOVER AND EVALUATE EDUCATIONAL OPPORTUNITIES GLOBALLY FOR STUDENTS TO ADDRESS GLOBAL GRAND CHALLENGES AND/OR UN SDGS IN THEIR UG OR PG RESEARCH OR CAPSTONE PROJECT

DISCOVER AND EVALUATE EDUCATIONAL OPPORTUNITIES GLOBALLY FOR STUDENTS TO WORK COLLABORATIVELY WITH STUDENTS IN OTHER COUNTRIES ON FINAL YEAR RESEARCH OR CAPSTONE PROJECTS

DISCOVER AND EVALUATE EDUCATIONAL OPPORTUNITIES GLOBALLY FOR STUDENTS TO PARTICIPATE IN TEAM OR PROJECT-BASED TRANSNATIONAL EDUCATIONAL ACTIVITIES OUTSIDE OF RESEARCH OR CAPSTONE PROJECTS WHICH ADDRESS GLOBAL GRAND CHALLENGES AND/OR UN SDGS



AMENA JAMIL, COREY JONES, HOLLY PALMER

BSc Biological Sciences, BA (Int) Digital Media, BSc (Ind) Pharmacology

Supervisor: Dr David Lewis

Faculty of Biological Sciences, University of Leeds

Submitted in accordance with the requirements for the degree of B.Sc. Biological Sciences. The candidates confirm that the work is submitted in accordance with the Declaration of Academic Integrity previously signed by the candidates.

We thank The Laidlaw Foundation for their continual commitment, mentoring, guidance, and financial support, contributing towards the eventual outcomes of this Laidlaw Research Project.

EXECUTIVE SUMMARY

The 2030 Sustainable Development Agenda acts through 17 Sustainable Development Goals (SDGs) to address poverty, environmental sustainability and improve the quality of life across the globe. Global Grand Challenges are a separate family of initiatives with an aim to help combat world health and development problems. This Systematic Review assesses what educational opportunities students must address the Global Grand Challenges or SDGs in their final year research or Capstone project and whether they can work collaboratively with students from different countries. After finalising a suitable methodology, a full comprehensive search of the literature was completed through 3 separate search strings to address 3 related research questions. The findings of the review highlight that there are 82.0% more papers focusing on SDGs than Global Grand Challenges and that SDG 4 was the most researched goal, appearing in 22.4% of the papers. Overall, whilst there is some evidence for advancements in addressing global sustainability problems, it remains under researched, and students currently do not have much of an opportunity to address SDGs or Grand Challenges in their Capstone project. In addition, studies have shown that TNE can advance and add value to research projects and yet, there are still only a small number of universities taking part in this.

INTRODUCTION

The Glossary of Educational reform defines a Capstone project as a "multi-faced project that serves as a culminating academic and intellectual experience for students" (Anon, 2021). The main objectives of capstone projects include providing a more challenging and arguably academically stimulating final year for students in preparation for future work-life; increasing student motivation and engagement since capstone projects are usually of a student's choice and based on global issues and demonstrating learning and proficiency (Anon, 2021). Capstone projects tend to be the final assignment a student completes, which can reflect their skills and knowledge on a specific subject area. These types of projects allow students to prepare themselves for the working world by offering them hands-on experience, as well as a basis to explore real-life global issues from an innovative point of view (L, 2021).

Sustainable Development Goals (SDGs)

Global issues presented to us today are highlighted by the United Nations within the 17 SDGs. The SDGs are a set of goals set out by the UN in hopes to achieve a more sustainable future, by tackling urgent political, environmental, and economic challenges, by 2030. The 2030 agenda is a recurring theme in the papers analysed, signifying its importance. The SDGs are a guideline with specific targets, aiming to guide businesses and the public to work towards a more sustainable future. Students performing capstone projects on subjects specific to SDGs can provide a unique perspective to one or more of these problems (Anon, 2021).

Global Grand Challenges

Like the SDGs, Global Grand Challenges are a 'family of initiatives fostering innovation to solve key global health and development problems. Each initiative is an experiment in the key use of challenges to focus innovation on making an impact' (Grand Challenges, 2020). Initially launched by the Bill and Melinda Gates Foundation in 2003, their initiative set out 14 major scientific challenges with the aim to lead to 'key advances in preventing, treating and curing diseases and health conditions contributing most to global health inequity'. SDGs set out specific targets outlining what can be achieved to achieve a sustainable future, whereas the Grand Challenges take steps to address how these global challenges can be achieved (Singer, 2014).

However, the Grand Challenges are also individual to each country, with the UK's being set by the 'Industrial Strategy'. These are focused on: Artificial Intelligence and Data, Ageing Society, Clean Growth and Future of Mobility (GOV.UK, 2021). Each Grand Challenge is broken down into sub-sections, with the UK's largely focussing on the economy within AI and 'data revolution'. It hopes that "embedding AI across the UK will create thousands of good quality jobs and drive economic growth." (GOV.UK, 2021). Their mission is to "use data, AI and innovation to transform the prevention, early diagnosis and treatment of chronic diseases by 2030." (GOV.UK, 2021). Secondly, the Government wants to "harness the power of innovation to help meet the needs of an ageing society…if we succeed, we will create an economy which works for everyone, regardless of age." (GOV.UK, 2021). The mission for Ageing Society involves "ensure[ing] that people can enjoy at least 5 extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and poorest". Grand Challenges can also focus largely on the environment, as the UK plans to:

> "Maximise the advantages for UK industry from the global shift to clean growth - through leading the world in the development, manufacture and use of low carbon technologies, systems and services that cost less than high carbon alternatives." (GOV.UK, 2021).

Their missions within clean energy involve halving the energy use of new buildings by 2030 and establishing the first net-zero carbon industrial cluster by 2040, with >1 low-carbon cluster by 2030. Penultimately, the UK aims to be a world leader in shaping the future of mobility, driven by the "extraordinary innovation in engineering, technology and business models." Their final mission involves "Put[ting] the UK at the forefront of the design and manufacturing of zero emissions vehicles, with all new cars and vans effectively zero emission by 2040." (GOV.UK, 2021).

Transnational Education

Transnational education (TNE) is "education delivered in a country other than the country in which the awarding institution is based, e.g., students based in country Y studying for a degree from a university in country Z" (UK, 2021). Transnational education can be delivered in various

ways, through online and distance learning, joint and dual degrees, local delivery partnerships or via a branch campus (like the University of Nottingham's branch campuses in Malaysia and China).

Within Capstones, the opportunities for Transnational Education are increasingly important, particularly within countries that are higher economically developed. Particularly common within the USA and the UK, students can often study in foreign countries whilst attaining a degree from the universities home country. Within the article 'Double standards: when an undergraduate dissertation becomes the object of two different assessment approaches', students residing in the Czech Republic can obtain a baccalaureate degree from an accredited American College, where "part of the degree assessment is an undergraduate dissertation, which serves as a capstone experience." (Starr-Glass and Ali, 2012). The Czech University agreed that with the same undergraduate dissertation, local students would obtain a 2nd degree, clearly showing the potential benefits of transnational education, providing students with an increased advantage over others who reside in one country to complete their degree.

Aims

The research conducted in this paper focuses on but isn't limited to SDG4 – "To ensure inclusive and equitable quality education and promote lifelong learning opportunities for all". The research questions addressed in this study are as follows: 1. Discover and evaluate educational opportunities globally for students to address the Global Grand Challenges and/or UN SDGs in their UG or PG research or capstone projects. 2. Discover and evaluate educational opportunities globally for students to work collaboratively with students in other countries on final year research or capstone projects. 3. Discover and evaluate educational opportunities globally for students to participate in team or project-based transnational educational activities outside of research or capstone projects which address Global Grand Challenges and/ or UN SDGs. The aim of this systematic review was to assess the opportunities students must address these global sustainability problems in their final year projects and whether they can do this collaboratively.

METHODOLOGY

A Systematic Review

A Systematic Review was undertaken in June and July 2021, to locate papers relating to Global Capstones, the United Nations' Sustainable Development Goals (UN SDGs), Grand Challenges and Transnational Education.

Data Collection

Collectively, eight databases were accessed: OVID, Web of Science, Scopus, PubMed, Proquest, Communication & Mass Media Complete, British Education Index and Global Health. Texts were

located using Search String Terms, which were predetermined for the project. The three Search Strings (Appendix X) correlate directly with the three research questions provided.

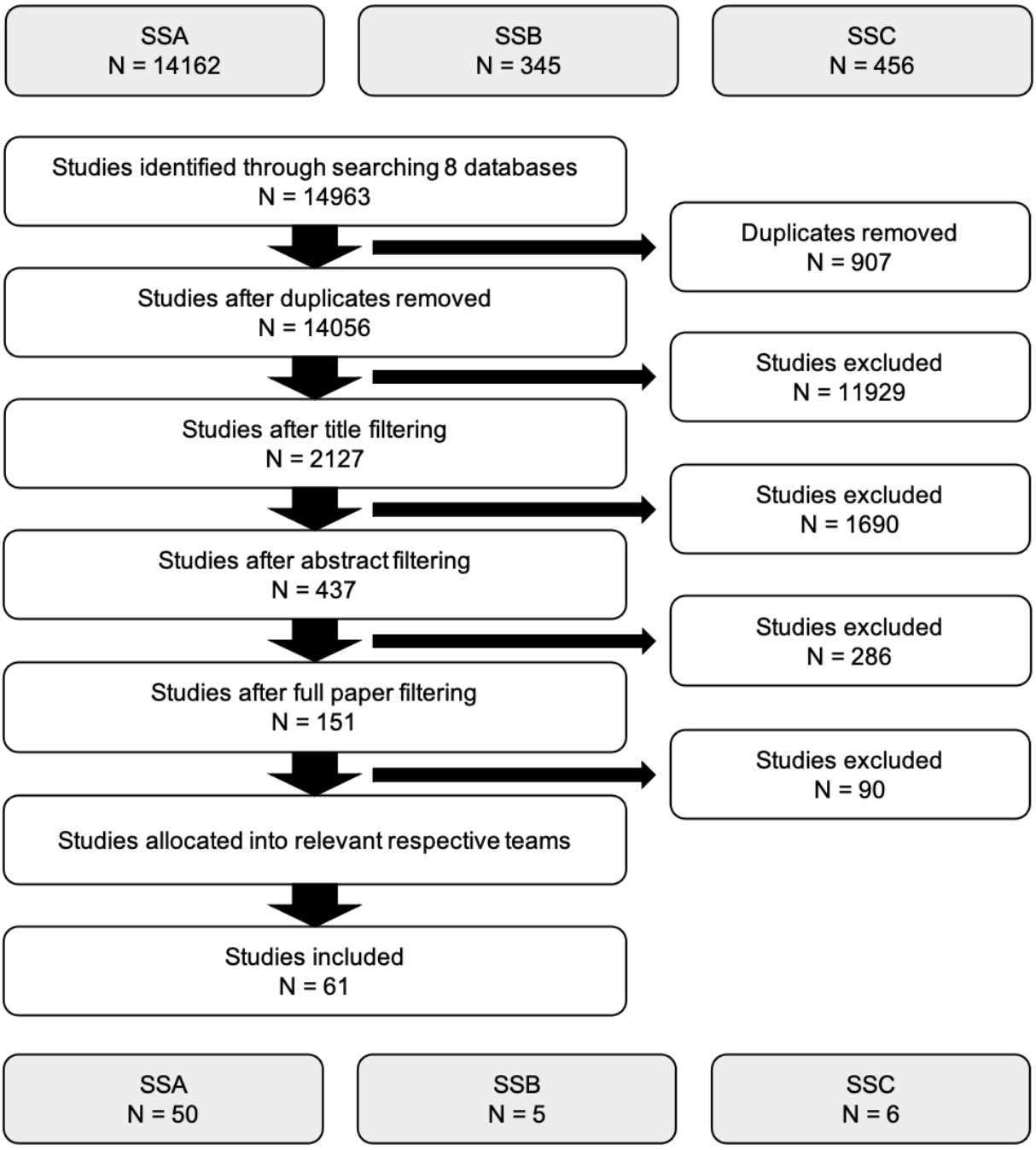
1. **Search String A**: (SS1 & SS2): Discover & evaluate educational opportunities globally for students to address Global Grand Challenges and/or Un SDGs in their UG or PG research or capstone project.
2. **Search String B**: (SS2 & SS3): Discover & evaluate educational opportunities globally for students to work collaboratively with students in other countries on final year research or capstone projects.
3. **Search String C**: (SS1 & SS3): Discover & evaluate educational opportunities globally for students to participate in team or project-based transnational educational activities outside of research or capstone projects which address Global Grand Challenges and/or UN SDGs.

Papers discovered were then imported into a collaborative EndNote library, and the filtering process commenced. Initially, duplicate papers were deleted.

Study Selection Process

The initial database search produced 14,963 results, with SSA covering the majority (94.6%). The second Search String (SSB) produced the smallest number of results, with 345 papers being imported into an online EndNote database. 8 databases were approached: OVID, Web of Science, Scopus, PubMed, ProQuest, Communication & Mass Media Complete, British Education Index and Global Health. Search String C provided the smallest number of keywords to be used, with it predominantly covering Transnational Education: ('TNE') OR ('Transnational Education') OR ('Trans-national education'). The process on each database involved using each of the Search Strings separately, and then using the 'AND' button to combine the two together, which drastically reduced the number of papers, as they had to have keywords from both Search Strings in. At each stage, papers were removed through the filtering process in the order of duplicates, title filtering, abstract filtering, and full paper filtering. Studies were then allocated into the relevant respective teams. Most papers were removed during duplicate filtering, with 11929 papers deleted. This is partially due to many the databases having shared ownership of the papers, so the papers were downloaded and imported into EndNote. After the filtering process, 61 studies were included; allocated into 50 papers in SSA, 5 papers in SSB and 6 papers in SSC.

FIGURE 1: A Prisma Diagram indicating how many papers were removed at each stage of the filtering process, initially dependent on the inclusion and exclusion criteria but then moved down to group judgement. The largest number pf papers were removed during title filtering.



Inclusion and Exclusion Criteria

To ensure the elimination of bias, pre-determined inclusion and exclusion criteria were used within the project. This allowed for papers to be efficiently sorted into folders. If a paper met any of the exclusion criteria, it was removed from the EndNote library. The inclusion criteria were strategic, and the papers were thoroughly screened, leaving behind those which fulfilled the inclusion criteria.

TABLE 1: The individual criteria used to determine whether a paper was included in the final reference list or removed. Pre-determined criteria that initiated the filtering process, which then moved onto personal judgement for abstract and title filtering and then full paper filtering before it was added to the final doc.

	Inclusion Criteria	Exclusion Criteria
Educational Establishment	University	FE/Community College
Degree Type	Undergraduate, Taught Postgraduate	Research Postgraduate, Taught Course
Year	All Degree Years	
Discipline	Any Discipline or Multidisciplinary	
Activity Type	Project or Team-Based Activity	
Type of Paper	Full Papers	Conference Abstract, Revie Article
Accessibility	Available at UoL	Not Available at UoL
Language	English Language	Not in English Language
Date	Any Date	

After the papers were filtered using the inclusion and exclusion criteria, a further process began. Papers were initially filtered using the abstracts to see whether they were relevant. Following this, the full papers were read, and the irrelevant ones were removed from the EndNote database.

Data Extraction and Analysis

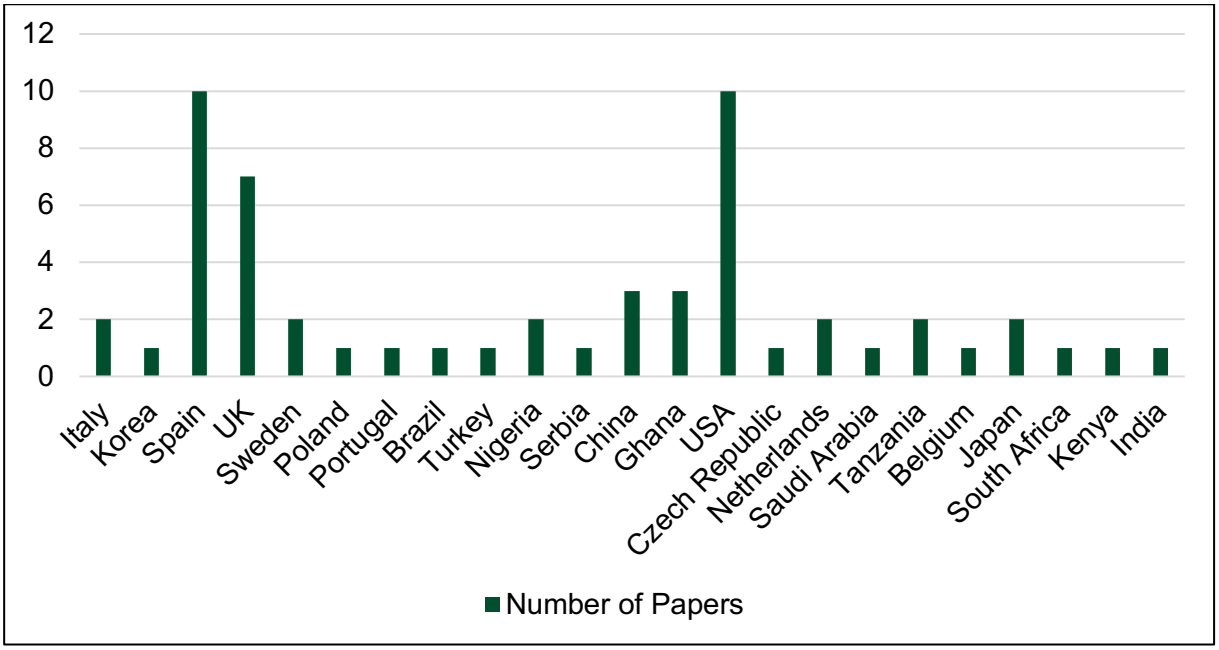
Data from the papers were extracted into a Google Sheets. This had columns titled: authors; title of text; journal, vol, page; paper weblink; ugrad/integrated masters/masters; programme/degree name; module or course name & weblink; single/inter/multi-disciplinary; disciplines involved; single university/multiple universities from single country/transnational education (students at uni in different countries working together on same project); names of countries where main & partner universities located; individual or team; full description of activity; grand challenge/SDG/both; detail of GC or SDGs; how are challenges/SDGs identified or decided; new project or activity each year or do next year's students take previous years project to next stage; assessment method(s) for students; details of success- how was success and impact of this educational activity measured or evaluated, what did success look like. How is this activity being developed; and any other comments/useful information. The papers were inputted in alphabetical order and sorted by type of data input when categorising them into quantifiable numerical data.

FINDINGS

SSA: Discover and evaluate educational opportunities globally for students to address Global Grand Challenges and/or UN SDGs in their UG or PG research or capstone project

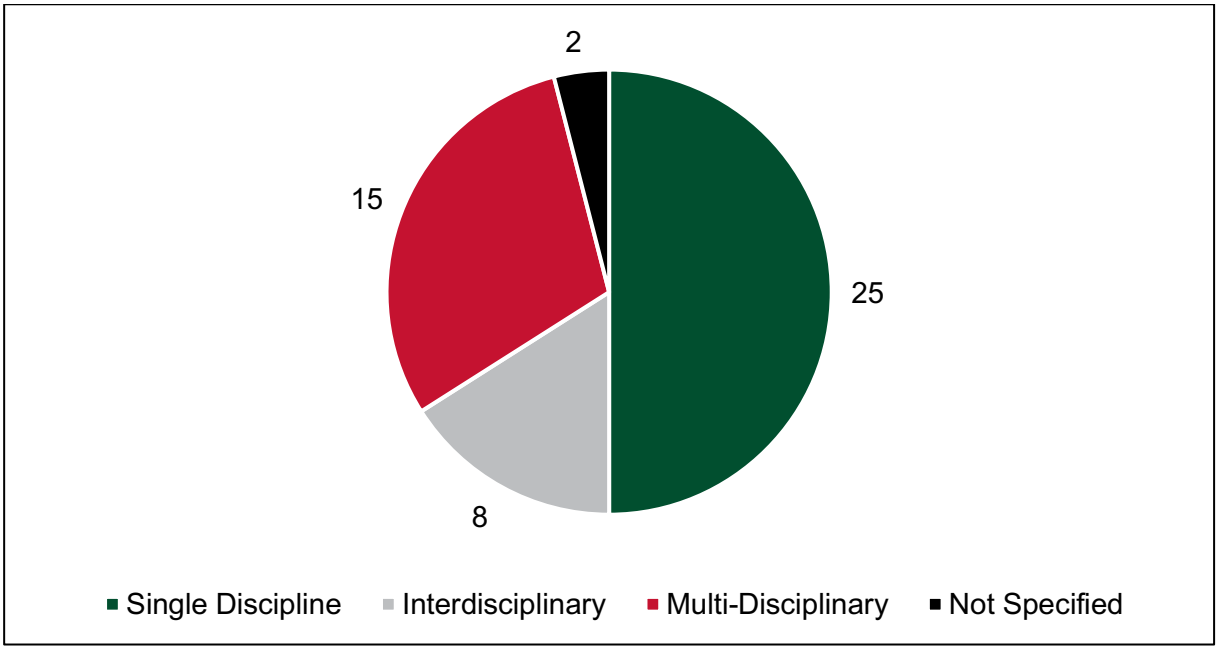
Geographically, there is a large distribution of studies with representation on every continent. However, except for a limited number of studies in 4 African countries (Ghana, Tanzania, Uganda, and Kenya), the findings of the review primarily revealed papers from Higher Income Countries. This suggests that there is a greater opportunity for students to address the Sustainable Development Goals in more developed countries, implying students will be benefited more when studying at a higher education facility in a more economically developed education system, this correlating directly with SDG 4; whereby increasing educational quality will have direct effects on the sustainability and progress of the wider world. The USA and Spain produced the highest number of studies, both with 15.9% of the papers, suggesting there is a higher desire to address the SDGs within university curriculums in these countries; this could be due to different systems of regulation of what is and is not in university curricula. In the US, for example, it is up to the individual university to make changes in their curricula, making it easier to add sustainable development problems into the university programmes, providing students in this area with more opportunity.

FIGURE 2: Most discovered papers originated from the USA and Spain, with the UK following closely after, indicative that HICs and more economically developed countries participated in Global Capstone Projects and research more often. A Bar Chart of the author's country of origin, with number of papers.



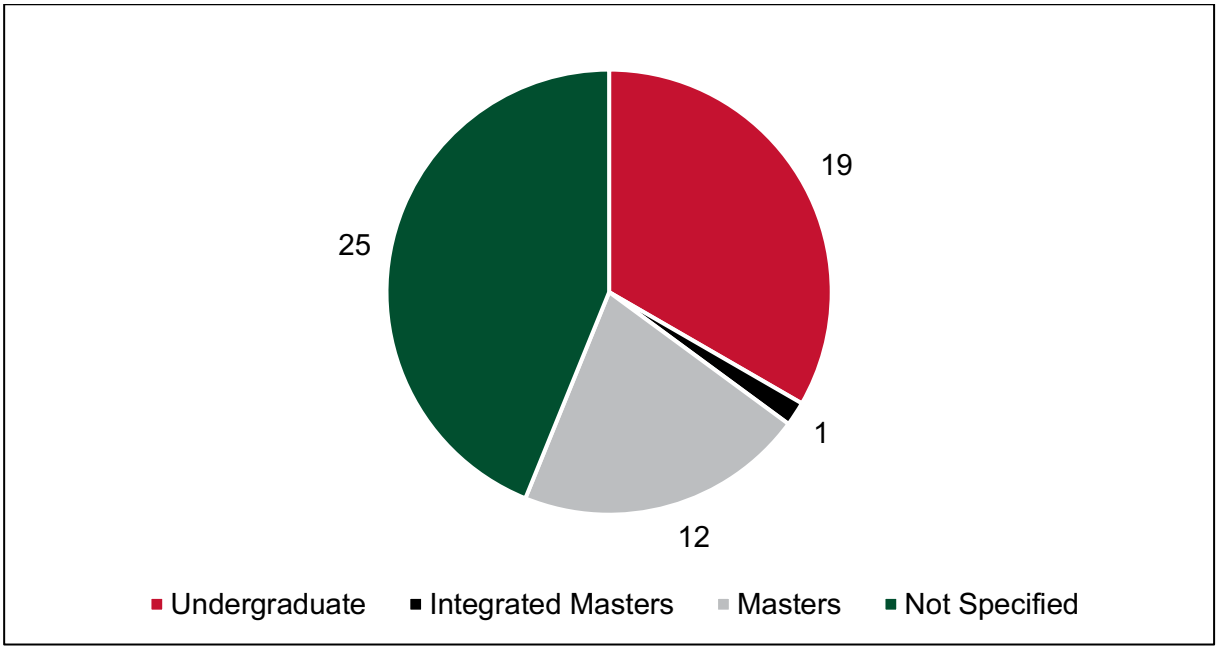
There was an uneven distribution of disciplines between the Global Capstone projects. Educational Studies, Sustainability and Business Studies held the highest proportion of papers, with Public Health, Economics and Engineering holding a slightly lower proportion of papers. This is expected however, as these disciplines have the greatest link to Grand Challenges or SDGs. 50% of these papers were single disciplinary and the other 50% were multidisciplinary, interdisciplinary, or not specified. This suggests there is a higher proportion of disciplines working within their own field to address the Global Grand Challenges or the SDGs rather than working collaboratively to progress the goals through more than one subject. This could suggest that Global Capstones addressing the Sustainable Development Goals lack the key infrastructure needed for students to produce projects advancing research globally and signifies it may be easier to carry out a capstone domestically, possibly exacerbated by the COVID-19 pandemic and the lack of ease of transportation internationally.

FIGURE 3: Most Global Capstone Projects predominantly focused on a single discipline of education, suggesting that getting different departments to collaborate on Capstone Projects is a recommendation for future research. A Pie Chart demonstrating the types and number of disciplines of education.



Furthermore, 43.9% of these studies did not specify whether the Global Capstone was undertaken at an Undergraduate or Postgraduate degree level. Of the papers that did specify, 59.4% were undergraduate and 37.5% were postgraduate. This suggests there is a slightly higher opportunity for students to address the Global Grand Challenges or the SDGs at an undergraduate degree level in their final year research project.

FIGURE 4: Most discovered papers didn't specify the degree of education they undertook the Global Capstone at, making it hard to identify when it was undertaken. A Pie Chart revealing the degree of education the papers and projects were undertaken at.



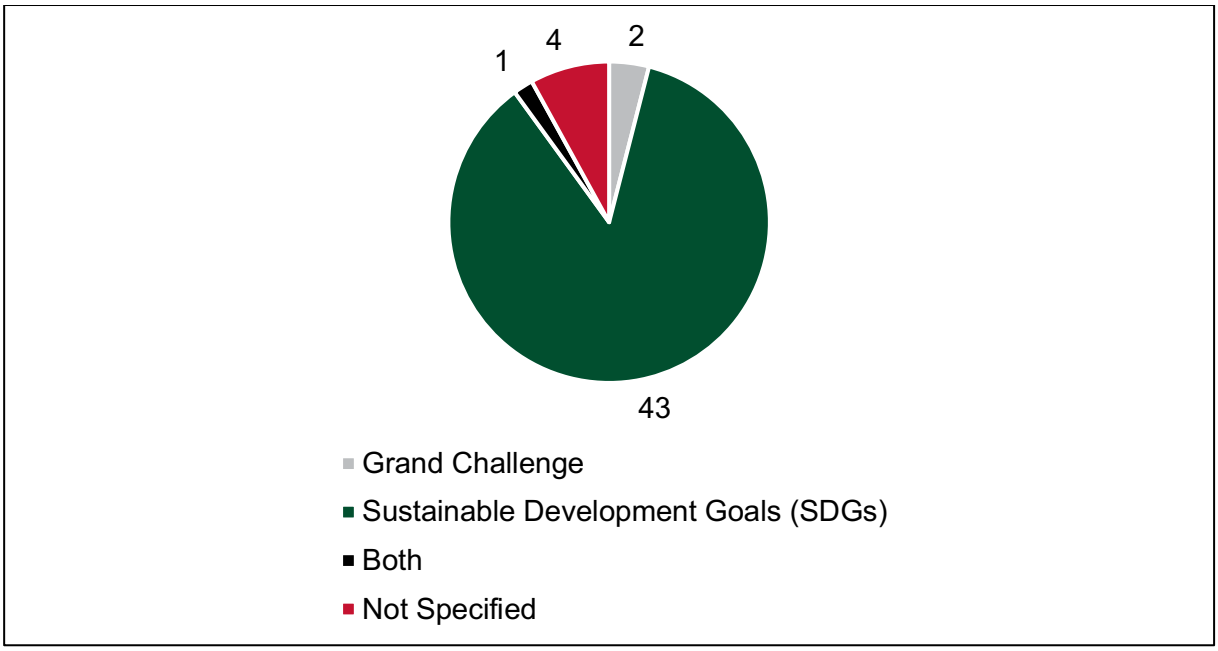
Details of the Final Year Projects

After analysing the data of the Capstone Projects there was a higher focus on addressing SDGs (86% of the papers), compared to the Global Grand Challenges, which accounted for only 4% of the papers. This therefore shows there is a lack of integration of Grand Challenges into university degree programmes and outlines a path for improvement.

As previously mentioned, 15.9% of the papers were written by students in Spanish universities. The prime focus of most of these studies is SDG 4– to improve the quality of education within Spanish universities. A variety of methods were used within these studies. For example, The University of Murcia allowed students to participate in a questionnaire set to highlight the strengths and weaknesses of an economics course, extracting these strengths, and applying them to other subject areas (Cifuentes-Faura, 2020). Whereas University of Valencia took a different approach, implementing a higher performance academic programme into their teaching, for high performing students, in which they attempted to compare graduate employability with students who attended the academic programme, and those who did not (Clemente, 2020). These studies are both considered successful as they provide crucial information on how the university's current methods of education are affecting students academically to improve the quality of education for all students. These studies can be considered a guide for other universities to follow when considering updating their curriculum to incorporate the SDGs. Typically, SDG 4 is addressed in a country-wide context,

highlighting the abnormality in this case of discussing the goal within papers only addressing a single university's educational system.

FIGURE 5: A large majority of papers addressed the Sustainable Development Goals, compared to a fractional amount addressing Grand Challenges. 4 papers did not specify their topics, making it difficult to decipher the information. A Pie Chart demonstrating which topics are addressed in the papers.



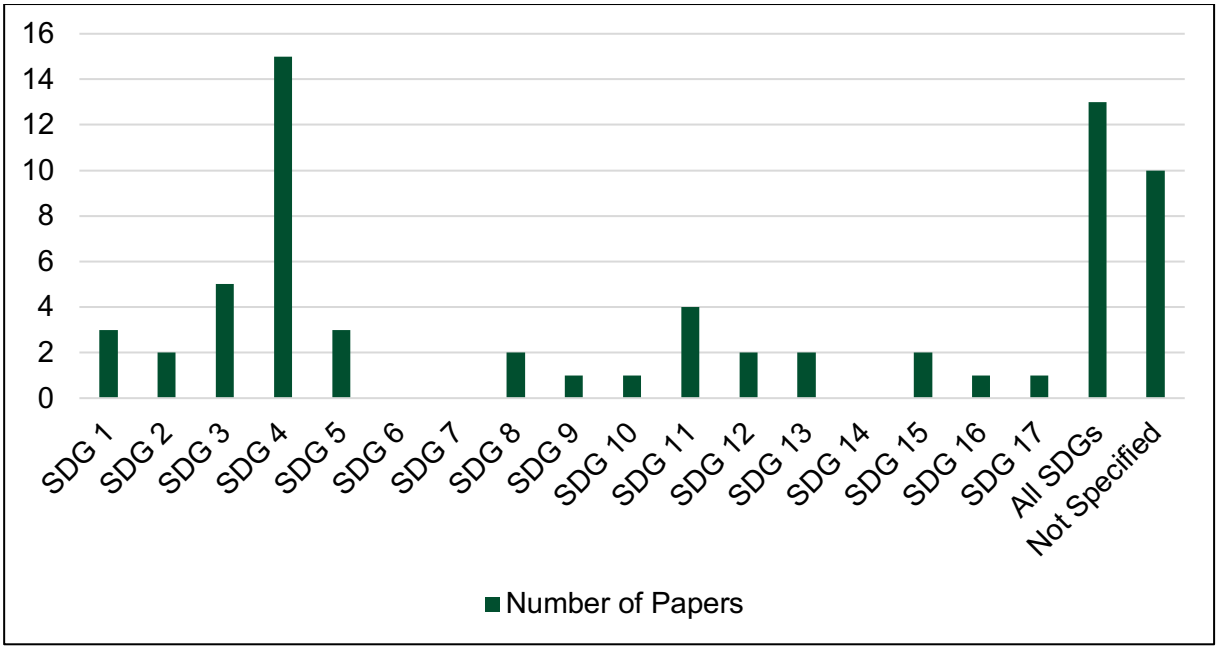
One of the institutions that did address the Global Grand Challenges was Texas A&M University working on 'Overcoming disciplinary divides in higher education'. The case study explored within the paper is the interdisciplinary subject of Agricultural Economics, in which students expand their knowledge and undertake projects to address the Grand Challenges. (Desmond et al., 2019). The value of using an interdisciplinary approach is highlighted with the belief that 'integrating the insights of different disciplines provides a more comprehensive solution than can be offered by any given discipline' (Desmond et al.,). This study highlights the advancements in addressing the Grand Challenges using this approach such as 'poverty, hunger, ecological stability and agricultural development' that have required a depth and breadth of knowledge that students from the department of economics could not provide unassisted. This suggests a potential way forward for single disciplinary projects is to involve students from other disciplines to address the global sustainability problems, whether that be Global Grand Challenges or SDGs.

However, this research project was only partly successful. Whilst the conclusion was made that 'shared communications are key to overcoming interdisciplinary conflicts' and that 'complexity

science can be useful in addressing [grand challenges]', it has been suggested that most of these projects are not 'substantially different from the academic disciplines…they were originally designed to challenge' (Kleinburg, 2008). The internal conflict comes from differing beliefs in the priorities of the projects, with some of the department wanting to study the 'normal science' of economics but facing the pressure of having to 'integrate disciplines that do not conform to the 'normal science' of their department's core. This suggests that while the idea of multidisciplinary research seems more advanced, the execution of the projects is not straightforward and highlights that further work and research should be carried out in this area to have a seamless integration of more than one discipline.

There was an uneven distribution of the SDGs that have been addressed throughout the capstones. SDG 4, the Global Education Goal, held the highest number of papers at 22.4%. This was predicted as the search strings used had a focus on education, so whilst the study may have discussed other SDGs, a prime focus on implementing these into the education system is more evident, and therefore falls under the category of SDG 4. 19.4% of the papers discussed all the SDGs and 14.9% of the papers did not specify which SDG they were addressing and instead discussed sustainability. Evidently, this is a less effective way of moving forward and addressing the SDGs, as it is more efficient to identify specific SDGs. This is because there will be a clearer ideology and methodology, and results will be clearer.

FIGURE 6: Many papers addressed SDG 4 (Education) or discussed all the SDGs. However, many papers didn't specify which SDGs they were addressing making it difficult to quantify the data from the papers. A Bar Chart showing which SDGs the papers addressed.



Another struggle faced by research projects was the localisation of SDGs or Grand Challenges. As these goals have been 'agreed and signed by national governments... implementing them at a local level requires a process of adaptation' (Valenica et al., 2019). A study by 'Valencia et al' addressed this issue and analysed ways of implementing these goals at a local level within seven cities across four continents. Researchers from the project have been embedded within the countries to have a first-hand, real-world experience of addressing the SDGs, with a particular focus on SDG 11 (the urban goal). For example, in Cape Town, the researcher was embedding into their Organisation Policy and Planning department, working with the team to localise the SDG. The study established 5 aspects to consider when implementing the goals, including: 'delimitation of the urban boundary' and 'integrated governance'. The study concluded that 'the cities studied... are starting to engage at different paces with the global agendas' but have 'not [yet] adjusted their existing monitoring mechanisms' and there is a lack of 'clear guidance' from 'national governments' in most cases.

The Capstone projects encountered challenges such as a lack of involvement from universities. For example, in a study undertaken by the Università di Torino, Italy, just 18 out 51 universities voluntarily answered the call for the study's primary research and therefore data cannot be collected for those universities that did not participate (Sonetti et al., 2020). Furthermore, other limitations of these research projects include lack of resources and financial support, especially with students from lower income countries. For example, in a study outlining Tanzania's educational challenges, limitations to research included: 'lack of comprehensive research database', 'dissemination of research results', 'low level of research funding' and 'lack of reading and writing culture'. Limitations such as these can be overcome when collaborating students from other universities, potentially in other countries that do have the resources needed to progress the research.

SSB: Discover and evaluate educational opportunities globally for students to work collaboratively with students in other countries on final years research or capstone projects

The research was expanded to address the second research question: to "Discover and evaluate educational opportunities globally for students to work collaboratively with students in other countries on final year research or capstone projects." The data extraction provided information on whether students worked individually or as a team and if the latter, whether that be with students from their own university, different universities from the same country or with students from different countries.

In the studies found from SSA, 74% of the projects were completed as a team. 54% of these studies were collaborations with students from the same university, 16% were collaborations with students from different universities in the same country and 36% were collaborations with students

from different countries. Therefore, for the projects addressing SDGs and Grand Challenges, most of the studies did not have the opportunity to work collaboratively with students from other countries. However, there could be other contributing factors to this high percentage, such as the COVID-19 pandemic, and a further study would be required to address this.

Furthermore, the search string for SSB, focusing on collaborations, extracted a limited number of papers. Before the inclusion and exclusion criteria we had 345 papers for SSB whereas there were 14,162 for SSA. The initially indicates that papers including collaborations were in a smaller number compared to those working individually.

FIGURE 7: Most Global Capstones were undertaken at a single university, suggesting they aren't as accessible and transnational education isn't as common as one might think. A Pie Chart demonstrating the status of universities involved within a Global Capstone Project.

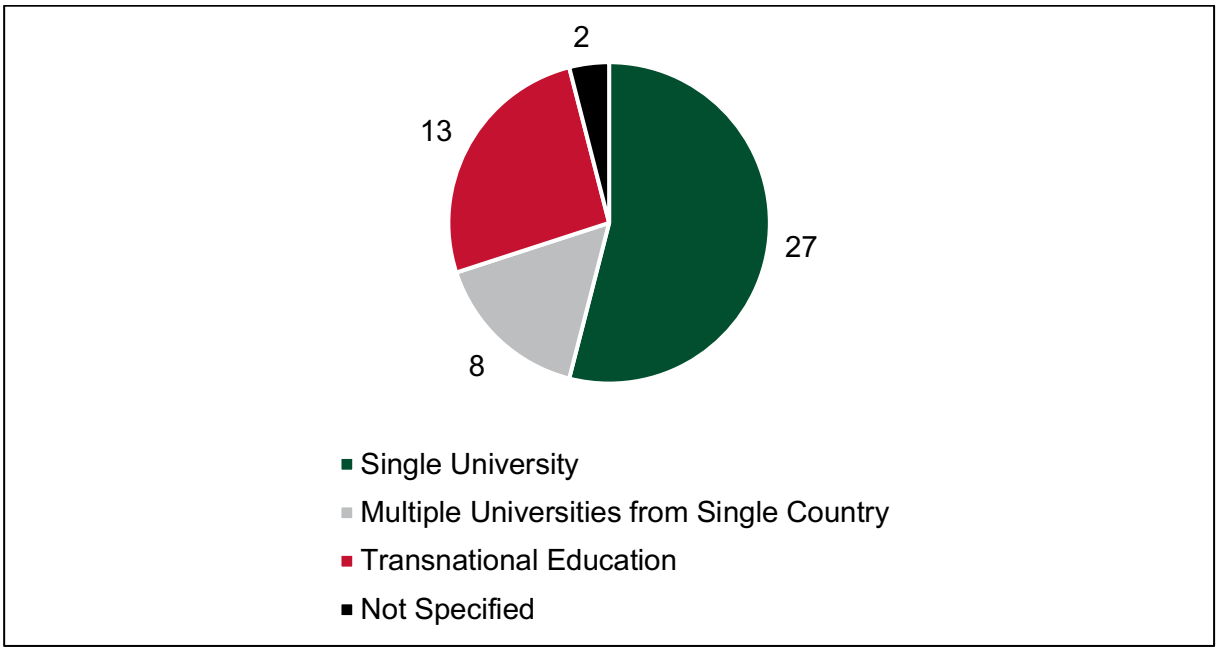
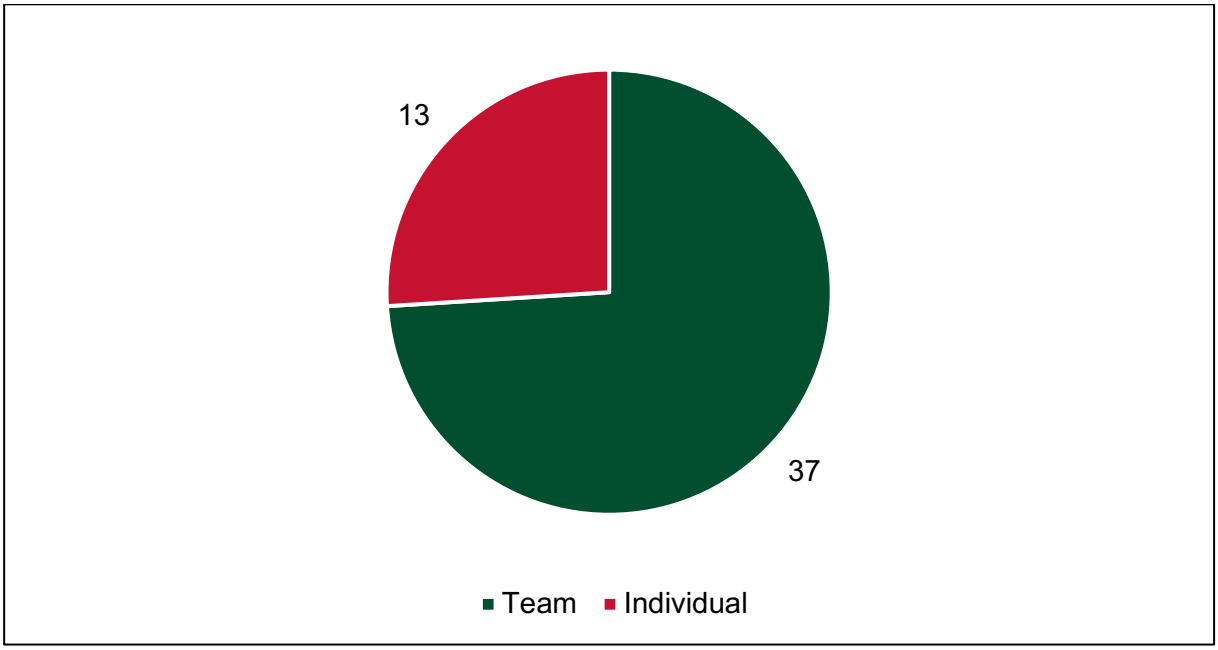
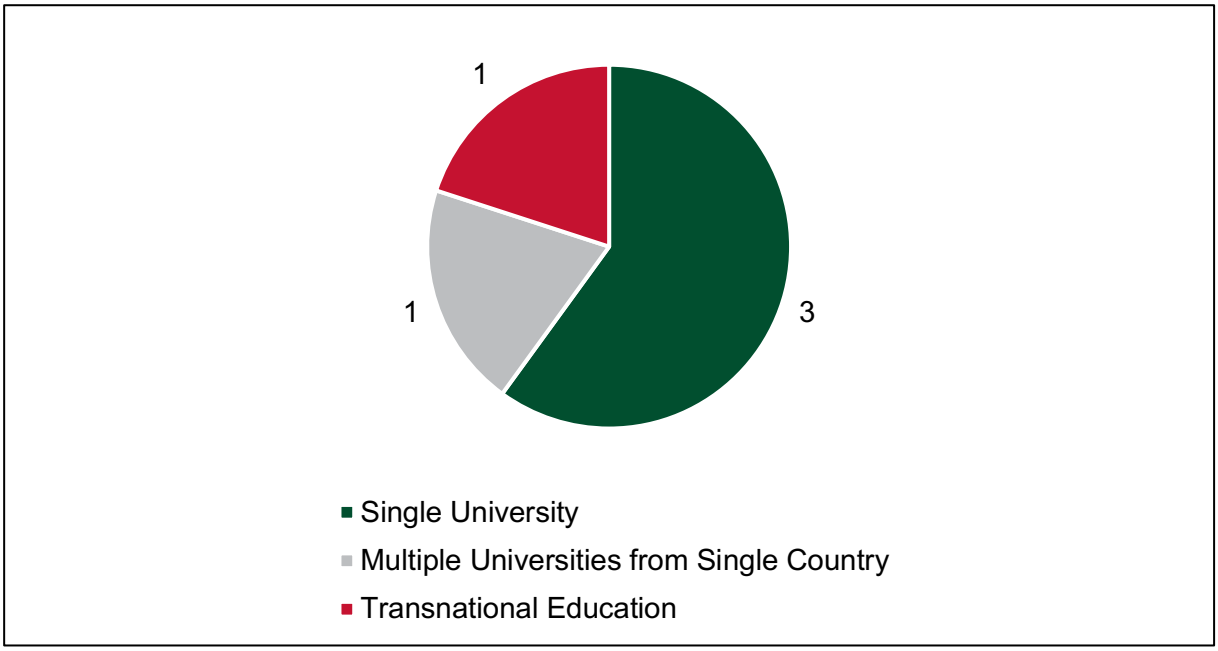


FIGURE 8: Almost three quarters of Global Capstone Projects are undertaken individually, suggesting that working collaboratively across multiple disciplines and transnationally seems to not have a large appeal. The COVID-19 pandemic may have affected this with limits on transportation globally. A Pie Chart showing the Research Style for the papers.



In one example of a collaborative study, researchers with expertise in diverse engineering disciplines aimed to 'map industry 4.0 enabling technologies into UN SDGs' (Mabkhot et al., 2020). The experts were split into 7 groups, depending on their area of expertise, each with a senior expert. The technology elements were first identified and then reviewed and discussed by each of the 7 groups, each providing a different viewpoint due to their different disciplines. The technologies then went through an updating and approval process. The influence of these technologies was then mapped to the SDGs using a quantitative measure. The measure identified how much of an influence the technology had on the SDG, whether that be 'direct', 'indirect' or 'no influence'. The study concluded that 'so far the strongest influence is on SDG 9- industry, innovation and infrastructure' and the weakest is for 'reduced inequality, SDG 10'. The work was said to open 'several further research opportunities' as the study has highlighted the value of the 4.0 technologies and areas for improvement. The use of collaboration in this study was effective as it allowed for the expert perspectives and opinions from academics in their own field and provided a multidisciplinary approach that advanced the research further than students from a single discipline. Another recommendation for the study was to make it more collaborative, including a higher number of academics from other related disciplines.

FIGURE 9: Most projects within SSB also were undertaken at a single university, implying this is a more frequent issue than initially believed. A Pie Chart showing the collaborative methods used in the papers.



Many of the studies extracted from this search string aim to use practical rather than theoretical approaches in completing their capstone project. For example, the UN AoC Youth programme encourages young people to develop their own cross-cultural projects and take practical action in promoting harmony among nations and cultures. Some of their successes include advancements in the Humanitarian Forum and facilitation of an international network of foundations in Madrid. It was suggested that capstones that involved real-world experiences, potentially with the students from the countries they were collaborating with, provided the students with a greater emotional involvement in the research they were completing and often resulted in a higher value project. Furthermore, there is a focus on competence-orientated learning with the goal to prepare students for the world beyond university. For example, the Bologna Process 'entailed a profound restructuring of the European Higher Education System in this respect' (Dolores, 2019). These modules often attempt to instil critical thinking and offer different contexts to promote action, encouraging students to envision the future (Dhloua et al., 2019).

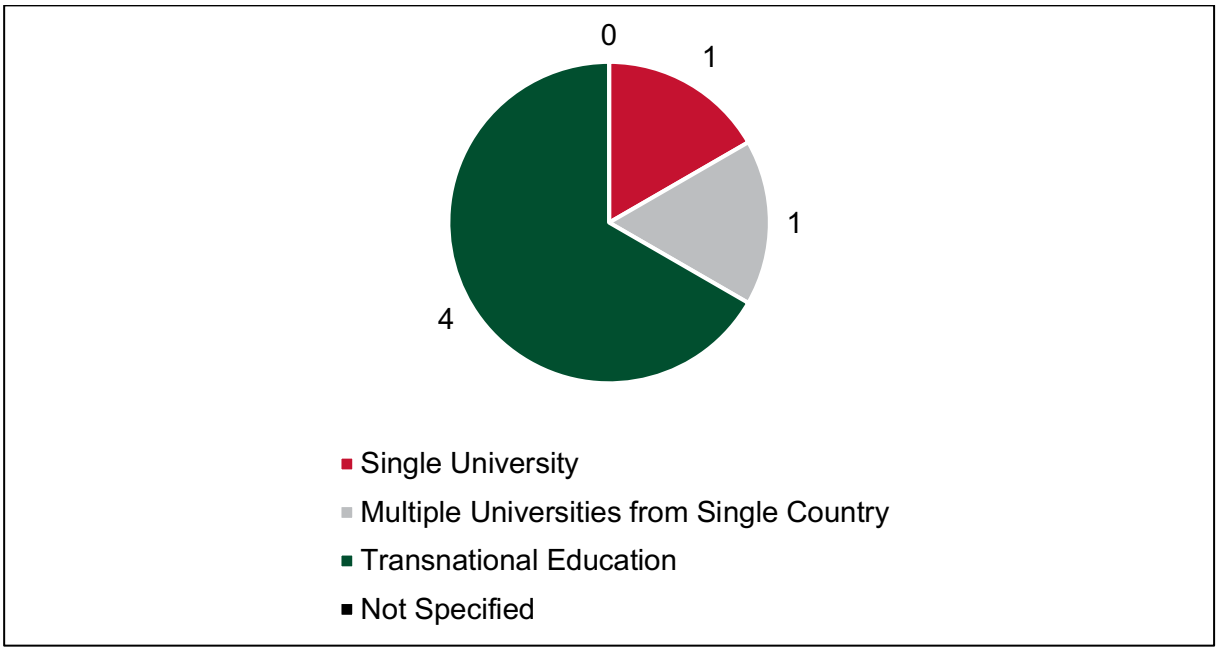
The findings of the review suggest that in studies with international collaborations, further advancements can be made and projects with a higher value completed in comparison to those from a single university. For example, a study from the University of Hong Kong outlines areas for improvement within the Chinese education system in terms of providing more TNE opportunities. The study suggests that there has been little research so far in this area. However, for the Chinese government TNE is seen to "boost the capacity of Chinese universities by accessing the world's most advanced education systems." The paper states that the appeal comes from '[offering] programmes

in partnership that they could not provide alone due to their lack of resources, expertise and prestige' (Yang, 2008).

SSC: Discover and evaluate educational opportunities globally for students to participate in team or project-based transnational educational activities outside of research or capstone projects which address Global Grand Challenges and/or UN

The output of the research conducted in Search String C led to only six papers being available. This highlights that Transnational Education is a quite an unknown subject area, not yet addressed by many organisations. With Globalisation expanding and our reliance on the internet growing by the day, Transnational Education's importance is increasing daily, with more research expected to be produced in the fore coming weeks and months. From the papers included, 66.7% were transnational, each having collaborated with a variety of different universities globally.

FIGURE 11: There are more educational opportunities globally for students to participate in transnational educational activities outside of research or capstone projects which address Global Grand Challenges and/or UN. This suggests that Capstone Projects are seen as an individual project produced by a singular university. A Pie Chart demonstrating the educational status of universities involved.



50% of studies were multidisciplinary with 55.6% focusing on education and the remaining 44.4% including: Social Sciences, Sociology, Geography, Medicine and Health. 50% of the papers were collaborations and 50% were individual. It was expected that the number of collaborations would be higher when addressing SSC, as transnational education is based around students

collaborating globally and working within a team, however this number may be lower due to the fact the extracted number of studies was lower than expected and so the data may not be representative.

The National University of Singapore ceased the opportunity to collaborate with Massachusetts Institute of Technology (MIT), to use transnational education as a way forward in making Singapore a 'knowledge and education hub' (Brenda,2011). The methods used in this study included interviews, surveys, and document analysis of government policies. The main objective of this study was to highlight how a TNE opportunity could help NUS in achieving its goal in becoming 'leading university in Asia' to produce 'qualities of entrepreneurialism, creativity, and cosmopolitanism in their graduates'. Although it isn't specified this paper is based around SDG 4, this is made clear by the fact the study highlights the importance of Singapore improving its education system for its sustainable development.

FIGURE 12: With a smaller data set, it is evident that data will seem more dramatic; with single discipline and multi-disciplinary papers both taking 50% of the methods. A Pie Chart demonstrating the disciplines involved in educational activities that aren't a research project or a Capstone.

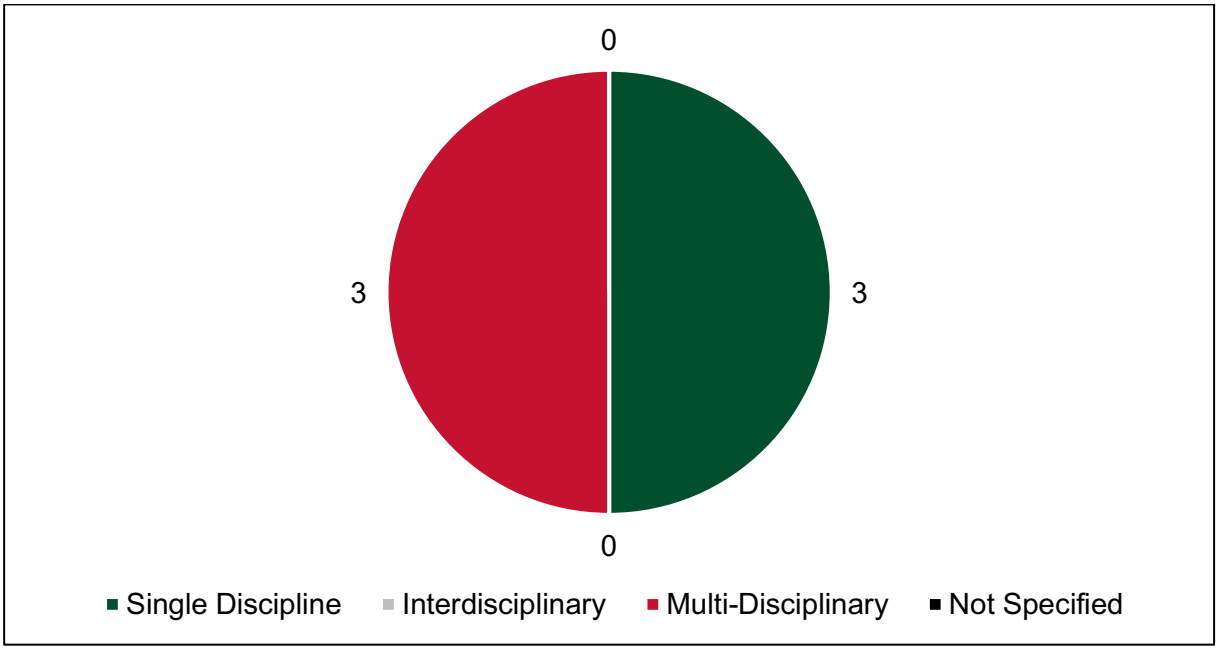
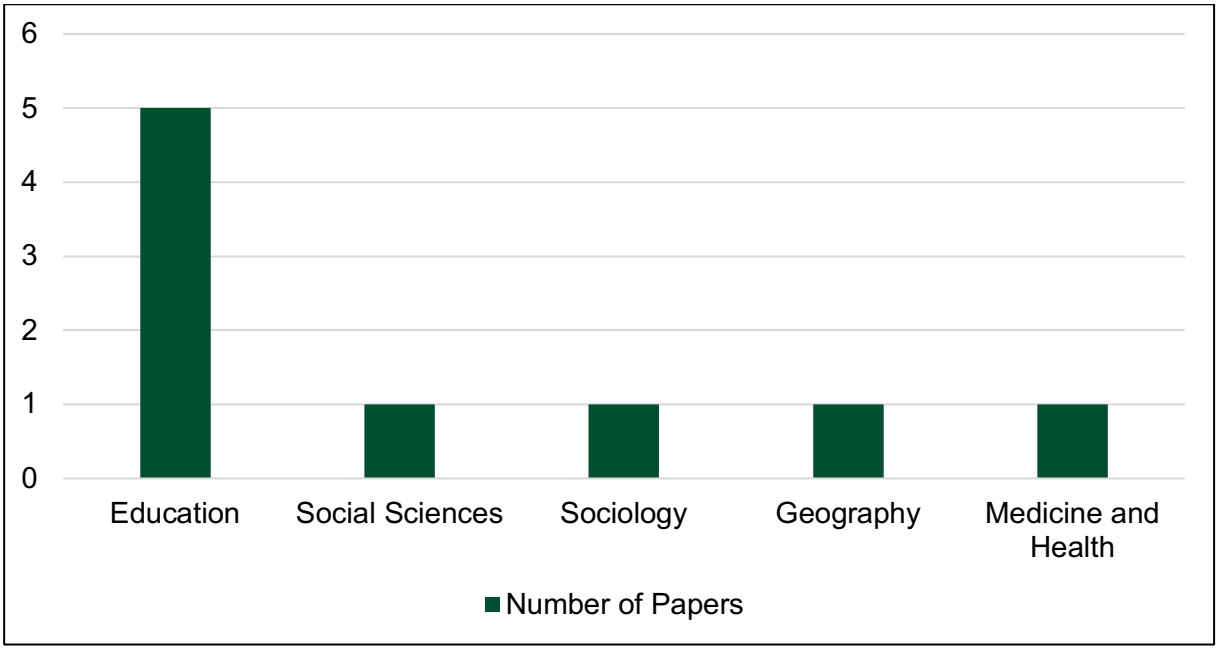
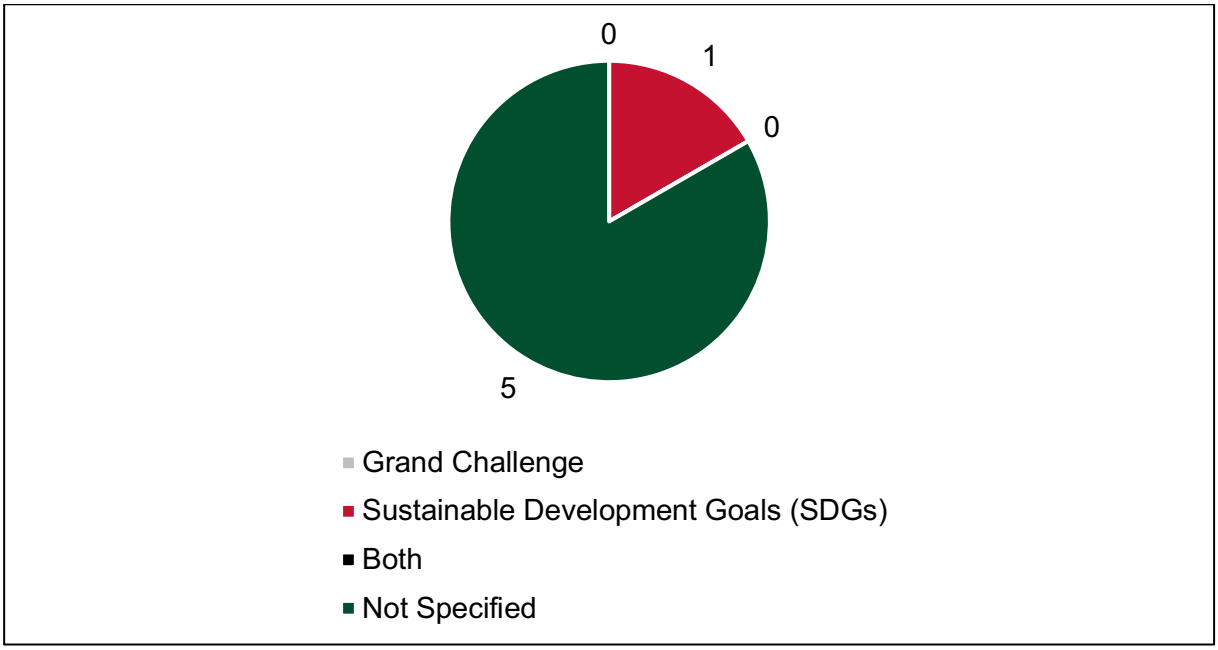


FIGURE 13: A strong majority of papers involved the topic of education, implying transnational education is a reflective discipline and can be discussed internally as well as externally. A Bar Chart revealing the degree programmes or disciplines involved with the papers in SSC.



Looking at the topics addressed, it is evident that the data extracted isn't specific to the research question relating to SSC, since only 16.67% of data is specific to SDGs and the remaining 83.3% is not specified. Again this could be due to the data not being representative due to the small sample set, or even possibly due to the fact there may not be enough data available on transnational education relating to SDGs and Global Grand Challenges to analyse. No data was obtained on Global Grand Challenges relating to transnational education, as expected from looking at previous data a small proportion of SSA was targeted at Global Grand Challenges and none of the sources in SSB were targeted at Global Grand Challenges.

FIGURE 14: Projects within SSC don't specifically address Grand Challenges or the Sustainable Development Goals, with the focus being Transnational Education. A Pie Chart showing the topics addressed within the projects in SSC.



From what was extracted, the paper relating to SDGs looks at SDG 3 and SDG 5- Sexual and reproductive health targets. This single disciplinary paper isn't completely relevant to the question, but the lack of relevance conveys to us that more research needs to be done on the SDGs and Global Grand Challenges relating to transnational education, since this clearly shows that there aren't many opportunities globally for students to participate in team or project- based.

DISCUSSION

The findings of this study highlight both successes of students in completing their Capstone Projects and the areas lacking research. The value of this review comes from our methodology. The systematic review extracted all papers related to the chosen search string within the databases. Therefore, the evidence extracted from the papers should be a full representation of the studies available and the lack of evidence highlighted proves there is a lack of research in that area. Furthermore, the inclusion and exclusion criteria is methodical and structured and therefore eliminates bias. The project was team based and deleted papers were peer-reviewed prior to removal from the endnote database, further eliminating bias.

The use of global capstones to address SDGs has been partially successful. There is sufficient evidence to suggest that several the Capstone projects were successful in addressing their research question and making advances regarding SDGs. For example, in a multidisciplinary study completed

by multiple universities in Turkey, the qualitative report outlined a list of findings addressing the research question that can be directly applied to SDG 4. However, there are a lack of studies addressing Global Grand Challenges with only 4% of the papers surrounding this topic. This could potentially mean there is little opportunity for students to study Global Grand Challenges, or just that students have chosen to base their capstone projects on the SDGs instead. However, if SDGs are seen as the targets and Grand Challenges address the steps needed to achieve these targets then students may have included Grand Challenges without explicitly stating that in their study.

There is a wide geographical distribution of papers although some countries hold a higher percentage of the papers than others, particularly the USA and Spain. However, most of these papers are produced from universities with a more developed education system in a higher income country. Some of these papers are discussing the educational or sustainability problems in lower income countries showing there is intent for improvement, but more research and support is needed in this area. The findings of the review show that universities have started more TNE programmes and there are more collaborations with universities in less developed countries. However, there was still a higher percentage of papers from single universities and therefore still a need for these collaborations.

The limitations of the studies are highlighted throughout the review. Whilst many universities are taking the necessary steps to implement SDGs and Grand Challenges into their curriculum, there is still a lack of involvement from some universities and thus comprehensive reviews of the programmes already out there prove challenging. In lower income countries where the higher education systems are underdeveloped anyway, adding sustainability programmes into their curriculum seems unachievable. Thus, support from those more developed universities is needed to progress this. Another limitation of the studies is within the single disciplinary papers in which the students are often subjectively limited and therefore cannot progress their research.

This review has highlighted that there is still a lack of papers regarding Global Capstone Projects involving SDGs and Global Grand Challenges. Whilst initially, the search strings extracted 14,963 papers, most of these were found irrelevant due to the exclusion criteria, leaving the review with limited studies, especially for SSB and SSC. Furthermore, most of these studies focused on SDGs (86% of the papers) and thus the data for Global Grand Challenges was severely limited. Thus, the data extracted for this study involving Grand Challenges may not be valid as the information is extracted from such a small number of papers.

CONCLUSION

The SDGs and particularly the Global Grand Challenges are under researched, and students do not have the opportunity to address them in their final year/ capstone project. Whilst our initial search string extracted many papers discussing global sustainability problems, many of these were excluded due to the inclusion/exclusion criteria and were not relevant to the research questions. Whilst there are papers reviewing the current systems in place to address SDGs, there are few studies addressing the goals themselves. There is a lack of clarity regarding Capstone Projects; this included whether the papers were discussing Capstone Projects as a Disciplinary Perspective, or the researchers were undertaking a Capstone Project themselves, this made Data Extraction and the Filtering Process more time consuming as the lack of clarity created a 'grey area'. It is clear in every paper studied that more work is needed to address each of the SDGs and Grand Challenges, both in developed and less developed countries.

RECOMMENDATIONS

The findings of the review outline that future projects should collaborate with universities in lower income countries to provide the students with the resources and funding to be able to complete capstone projects to a higher accreditation and value. Whilst there is evidence of research for SDG 4, there is still minimal research regarding the other SDGs and thus this could be a path for improvement. Additionally, many of the papers addressed more than one SDG, or attempted to address the SDGs. This has proven to be less effective in progressing the goals and addressing the targets as there is no clear methodology in how to move forward with creating a more sustainable future. There are limited papers relating directly to SDGs or Grand Challenges in the context of TNE. This therefore highlights a lack of research in this area as the systematic review is comprehensive and should extract all papers of this subject.

ACKNOWLEDGEMENTS

We would like to acknowledge Dr David Lewis for all the support, assistance, and leadership throughout our 6-week initial research period. We would also like to thank the Laidlaw Foundation, who provided us the opportunity to participate in such an important project, for funding us and improving our leadership and management skills over the course of two years.

REFERENCES

CHALLENGES, G. 2021. *About Grand Challenges Initiatives* [Online]. Available: https://www.ntu.eu/news-archive/the-importance-of-the-sustainable-development-goals/.
[Accessed August 5 2021].

FANG, J., TANG, S., TAN, X. & TOLHURST, R. 2020. Achieving SDG related sexual and reproductive health targets in China: what are appropriate indicators and how we interpret them? *Reproductive Health*, 17**,** 1-11.

MBAGWU, F. C., LYAKA, M., KIWELU, J. E., NYANTAKYI-BAAH, L. & HOLMNER, M. 2020. Achieving Sustainable Development Goals Two and Three: Role of Academic Libraries. *Library Philosophy and Practice***,** 1-22.

VALENCIA, S. C., SIMON, D., CROESE, S., NORDQVIST, J., OLOKO, M., SHARMA, T., TAYLOR BUCK, N. & VERSACE, I. 2019. Adapting the Sustainable Development Goals and the New Urban Agenda to the city level: Initial reflections from a comparative research project. *International Journal of Urban Sustainable Development*, 11**,** 4-23.

CHENG-YU, Y. 2018. An Application of Sustainable Development in Indigenous People's Revival: The History of an Indigenous Tribe's Struggle in Taiwan. *Sustainability*, 10**,** 3259.

MARSHALL, S. 2019. Are New Zealand universities underperforming? An analysis of international enrolments in Australian and New Zealand universities. *Compare: A Journal of Comparative & International Education*, 49**,** 471-488.

OPOKU, D. G. J., AYARKWA, J. & AGYEKUM, K. 2019. Barriers to environmental sustainability of construction projects. *Smart and Sustainable Built Environment*, 8**,** 292-306.

SIDHU, R. 2009. The 'brand name' research university goes global. *Higher Education*, 57**,** 125-140.

UTHUP, T. 2010. BRINGING COMMUNITIES CLOSER: The Role of the Alliance of Civilizations (AoC)1. *Cross Currents*, 60**,** 402-418,479.

MUSTATA, R. V., BONACI, C. G., HINTEA, C. & NEAMTU, B. 2013. BUSINESS EDUCATION FOR SUSTAINABLE DEVELOPMENT: THE CASE OF ROMANIAN UNIVERSITIES. *Amfiteatru Economic*, 15**,** 802-818.

EDGLOSSARY. 2016. *Capstone Project* [Online]. Available: https://www.edglossary.org/capstone-project/ [Accessed August 4 2021].

MORALES, G., BROMAGHIM, E., KIM, A., DIAMOND, C., MAGGINI, A., EVERHART, A., GRUSKIN, S. & ANTHONY TIRADO, C. 2021. Classroom Walls and City Hall: Mobilizing Local Partnerships to Advance the Sustainable Development Agenda. *Sustainability*, 13**,** 6173.

WALTER LEAL, F., MIFSUD, M., MOLTHAN-HILL, P., NAGY, G. J., LUCAS VEIGA, Á. & AMANDA LANGE, S. 2019. Climate Change Scepticism at Universities: A Global Study. *Sustainability*, 11.

DLOUHÁ, J., HERAS, R., MULÀ, I., FRANCISCA PEREZ, S. & HENDERSON, L. 2019. Competences to Address SDGs in Higher Education—A Reflection on the Equilibrium between Systemic and Personal Approaches to Achieve Transformative Action. *Sustainability*, 11**,** 3664.

MORLEY, L., LEACH, F. & LUGG, R. 2009. Democratising higher education in Ghana and Tanzania: Opportunity structures and social inequalities. *International Journal of Educational Development*, 29**,** 56-64.

BOLGER, D. T., KAREN HUTCHINS, B., KRIVAK-TETLEY, F. E., MAGGS-KÖLLING, G. & TJITEKULU, J. 2018. Designing a Real-World Course for Environmental Studies Students: Entering a Social-Ecological System. *Sustainability*, 10**,** 2546.

NELSON-HURWITZ, D. C. & TAGORDA, M. 2015. Developing an undergraduate applied learning experience. *Front Public Health*, 3**,** 2.

STARR-GLASS, D. & ALI, T. 2012. Double standards: When an undergraduate dissertation becomes the object of two different assessment approaches. *Assessment and Evaluation in Higher Education*, 37**,** 179-192.

CHUNG, N., TYAN, I. & LEE, S. J. 2019. Eco-Innovative Museums and Visitors' Perceptions of Corporate Social Responsibility. *Sustainability*, 11**,** 5744.

SONETTI, G., BARIOGLIO, C. & CAMPOBENEDETTO, D. 2020. Education for Sustainability in Practice: A Review of Current Strategies within Italian Universities. *Sustainability*, 12**,** 5246.

PIROŞCĂ, G. I., ŞERBAN-OPRESCU, G.-L., BADEA, L. & DEDU, S. 2020. Education for Sustainable Development – An Evaluation of Students' Perceptions within the Bucharest University of Economic Studies. *Amfiteatru Economic*, 22**,** 346-361.

KOPNINA, H. 2020. Education for Sustainable Development Goals (ESDG): What Is Wrong with ESDGs, and What Can We Do Better? *Education Sciences*, 10**,** 261.

KIOUPI, V. 2019. Education for Sustainable Development: A Systemic Framework for Connecting the SDGs to Educational Outcomes. *Sustainability*, 11**,** 6104.

UENO, K., BALSIGER, J. & PRICE, M. F. 2020. Education for Sustainable Mountain Development: Preliminary Insights From a Web-based Survey of Opportunities. *Mountain Research and Development (Online)*, 40**,** R1-R8.

ARMENGOL, J., WEIGAND, S., VON TIEDEMANN, A., KREITER, S. & DUSO, C. 2019. Education in crop protection: Erasmus Mundus Joint Master Degree - European Master Degree in Plant Health in Sustainable Cropping Systems. *Journal of Biotechnology*, 305**,** S8.

ÁLVAREZ-OTERO, J. & MARÍA LUISA DE LÁZARO Y, T. 2018. Education in Sustainable Development Goals Using the Spatial Data Infrastructures and the TPACK Model. *Education Sciences*, 8.

MEHTA, K., ZAPPE, S., BRANNON, M. L. & ZHAO, Y. 2016. An educational and entrepreneurial ecosystem to actualize technology-based social ventures. *Advances in Engineering Education*, 5.

SIDHU, R., HO, K. C. & YEOH, B. 2011. Emerging education hubs: the case of Singapore. *Higher Education*, 61**,** 23-40.

HUDSON, B. 2019. Epistemic quality for equitable access to quality education in school mathematics. *Journal of Curriculum Studies*, 51**,** 437-456.

KOEHN, P. H. & UITTO, J. I. 2014. Evaluating sustainability education: lessons from international development experience. *Higher Education*, 67**,** 621-635.

KUDO, S., MURSALEEN, H., NESS, B. & NAGAO, M. 2018. Exercise on Transdisciplinarity: Lessons from a Field-Based Course on Rural Sustainability in an Aging Society. *Sustainability*, 10**,** 1155.

BRUGMANN, R., CÔTÉ, N., POSTMA, N., SHAW, E. A., PAL, D. & ROBINSON, J. B. 2019. Expanding Student Engagement in Sustainability: Using SDG- and CEL-Focused Inventories to Transform Curriculum at the University of Toronto. *Sustainability*, 11.

BABAJIDE, A., LAWAL, A., ASALEYE, A., OKAFOR, T. & OSUMA, G. 2020. Financial stability and entrepreneurship development in sub-Sahara Africa: Implications for sustainable development goals. *Cogent Social Sciences*, 6.

CRIVITS, M., PROVE, C., BLOCK, T. & DESSEIN, J. 2016. Four Perspectives of Sustainability Applied to the Local Food Strategy of Ghent (Belgium): Need for a Cycle of Democratic Participation? *Sustainability*, 8**,** 55.

CHAMBERLAIN, S., GONZALEZ, N., DOBIESZ, V., EDISON, M., LIN, J. & WEINE, S. 2020. A global health capstone: an innovative educational approach in a competency-based curriculum for medical students. *BMC Med Educ*, 20**,** 159.

FUSSY, D. S. 2019. The hurdles to fostering research in Tanzanian universities. *Higher Education*, 77**,** 283-299.

INTERNATIONAL, N. 2021. *The importance of the Sustainable Development Goals* [Online]. Available: https://www.ntu.eu/news-archive/the-importance-of-the-sustainable-development-goals/. [Accessed August 4 2021].

DEPARTMENT FOR BUSINESS, E. I. S. 2018. Industrial Strategy: building a Britain fit for the future. *In:* BUSINESS, E. I. S. (ed.). London.

2021. Mapping Industry 4.0 Enabling Technologies into United Nations Sustainability Development Goals. *Sustainability*, 13**,** 2560.

2020. Mathematics Applied to the Economy and Sustainable Development Goals: A Necessary Relationship of Dependence. *Education Sciences*, 10**,** 339.

BALTA, M. E., COUGHLAN, J.-L. & HOBSON, P. 2012. Motivations And Barriers In Undergraduate Students' Decisions To Enroll In Placement Courses In The UK. *Journal of International Education Research*, 8**,** 399.

RAFAEL JUNQUEIRA, B., CANELAS, T., MARTINS DE CARVALHO, L., DUIM, E., RENATA FORTES, I., FONSECA, M., SOFIA LIZARRALDE, O. & NÚRIA SANCHEZ, C. 2018. MOVING TOWARDS THE SUSTAINABLE DEVELOPMENT GOALS: THE UNLEASH INNOVATION LAB EXPERIENCE. *Ambiente & Sociedade*, 21.

NIENS, U., REILLY, J. & MCLAUGHLIN, R. 2006. The Need for Human Rights Education in Northern Ireland: A Pupil Survey. *Peace confl.*, 12**,** 251-268.

NG, D. & LITZENBERG, K. 2019. Overcoming disciplinary divides in higher education: the case of agricultural economics. *Palgrave Communications*, 5.

ITO, H. & IGANO, C. 2020. Place-based environmental education to promote eco-initiatives: the case of Yokohama, Japan. *Regional Studies, Regional Science*, 7**,** 292-308.

ROS, J., LEE, C., BRUCE, M., FAN, C., QUAN, R. & PAI, H. 2006. A Portable and Sustainable Computer Education Project for Developing Countries-Phase 1. *International Journal for Service Learning in Engineering*, 1.

ORAKCI, Ş. 2020. Postgraduate Students' Expectations of Their Lecturers. *The Qualitative Report*, 25**,** 199-215.

SRIDHARAN, S., BONDY, M., NAKAIMA, A. & HELLER, R. F. 2018. The potential of an online educational platform to contribute to achieving sustainable development goals: a mixed-methods evaluation of the Peoples-uni online platform. *Health Research Policy and Systems*, 16.

GODDARD, J. T. 2007. The Professional Development Needs of Educational Leaders in Post-Conflict Kosovo. *The Educational Forum*, 71**,** 200-210.

STARR-GLASS, D. 2010. Reconsidering the international business capstone: Capping, bridging, or both? *Journal of Teaching in International Business*, 21**,** 329-345.

ANGELA YUNG CHI, H., SHENG-JU, C., LIN, L. & HU, Z. 2020. Student learning venture overseas in the transnational research partnership – a Taiwan and US PIRE case study. *Higher Education Evaluation and Development*, 14**,** 3-17.

CHEN, H., LING, L., MA, Y., WEN, Y., GAO, X. & GU, X. 2020. Suggestions for Chinese University Freshmen Based on Adaptability Analysis and Sustainable Development Education. *Sustainability*, 12**,** 1371.

ALSHUWAIKHAT, H. M., ADENLE, Y. A. & SAGHIR, B. 2016. Sustainability Assessment of Higher Education Institutions in Saudi Arabia. *Sustainability*, 8**,** 750.

RUIZ-MORALES, J., LIMÓN-DOMÍNGUEZ, D. & VALDERRAMA-HERNÁNDEZ, R. 2019. Sustainability in the University: A Study of Its Presence in Curricula, Teachers and Students of Education. *Sustainability*, 11**,** 6620.

NATIONS, U. *The Sustainable Development Agenda* [Online]. Available: https://www.un.org/sustainabledevelopment/development-agenda/ [Accessed August 4 2021].

2020. Sustainable Development Goals and 2030 Agenda: Awareness, Knowledge and Attitudes in Nine Italian Universities, 2019. *International Journal of Environmental Research and Public Health*, 17**,** 8968.

MARMOT, M. & BELL, R. 2018. The Sustainable Development Goals and Health Equity. *Epidemiology*, 29**,** 5-7.

2021. Sustainable Development Goals and Physical Education. A Proposal for Practice-Based Models. *International Journal of Environmental Research and Public Health*, 18**,** 2129.

ANTÓNIO VALTER, C. & COSTA, N. 2020. Teacher Education and Sustainable Development Goals: A Case Study with Future Biology Teachers in an Angolan Higher Education Institution. *Sustainability*, 12**,** 3344.

2015. Teaching 'community engagement' in engineering education for international development: Integration of an interdisciplinary social work curriculum.

ZAMORA-POLO, F. & SÁNCHEZ-MARTÍN, J. 2019. Teaching for a Better World. Sustainability and Sustainable Development Goals in the Construction of a Change-Maker University. *Sustainability*, 11**,** 4224.

MARUNA, M. 2019. Toward the Integration of SDGs in Higher Planning Education: Insights from Integrated Urbanism Study Program in Belgrade. *Sustainability*, 11**,** 4519.

ISMAEL MOYA, C., GABRIELA RIBES, G. & GISELA SANAHUJA, V. 2020. Towards Sustainability in University Education. Improving University Graduates Chances of Employability by Participation in a High Achievement Academic Program. *Sustainability*, 12**,** 680.

NÖLTING, B., MOLITOR, H., REIMANN, J., JAN-HENDRIK, S. & DEMBSKI, N. 2020. Transfer for Sustainable Development at Higher Education Institutions—Untapped Potential for Education for Sustainable Development and for Societal Transformation. *Sustainability*, 12**,** 2925.

YANG, R. 2008. Transnational higher education in China: Contexts, characteristics and concerns. *Australian Journal of Education*, 52**,** 272-286.

QS TOPUNIVERSITIES, S. L. 2021. *What Is A Capstone Project? And Why Is It Important?* [Online]. QS TopUniversities. Available: https://www.topuniversities.com/student-info/careers-advice-articles/what-capstone-project-why-it-important [Accessed August 4 2021].

UK, U. 2021. What is UK HE TNE? [Online]. Available: https://www.universitiesuk.ac.uk/International/heglobal/Pages/what-is-transnational-education.aspx [Accessed August 11 2021].

APPENDIX

Appendix 1: The list of the keywords categorised into the separate search strings used on the databases

Search String 1

(Advanced seminar) OR (Advanced seminars) OR (Capstone) OR (construction project) OR (Construction projects) OR (Culminating course) OR (Culminating courses) OR (Culminating experience) OR (Culminating experiences) OR (Culminating project) OR (Culminating projects) OR (Design project) OR (Design projects) OR (Exhibition) OR (Exhibitions) OR (Final year project) OR (Final year projects) OR (Final year research project) OR (Final year research projects) OR (Honors project) OR (Honors projects) OR (Honours project) OR (Honours projects) OR (Independent study project) OR (Independent study projects) OR (Internship) OR (Internships) OR (Legacy project) OR (Legacy projects) OR (Major project) OR (Major projects) OR (Maverick milestone) OR (Maverick milestones) OR (Practicum Research project) OR (Research projects) OR (Senior capstone experience) OR (Senior capstone experiences) OR (Senior experience course) OR (Senior experience courses) OR (Senior integration paper) OR (Senior integration papers) OR (Senior project) OR (Senior projects) OR (Senior seminar) OR (Senior seminars) OR (Senior thesis) OR (Senior theses) OR (Service learning) OR (Service-learning) OR (Signature project) OR (Signature projects) OR (Signature work) OR (signature works) OR (Summit course) OR (Summit courses)

Search String 2

(Grand Challenge) OR (Grand Challenges) OR (SDG) OR (SDGs) OR (Sustainable Development Goal) OR (Sustainable Development Goals) OR (Emerging World) OR (Developing World) OR (Global South) OR (International Development)

Search String 3

(TNE) OR (Transnational Education) OR (Trans-national education)

Appendix 2: A list of the Databases used within the Systematic Review

Ovid, Web of Science, Scopus, PubMed, Proquest, Communication & Mass Media Complete, British Education Index, Global Health

Appendix 3: A list of the Inclusion and Exclusion Criteria used within the Systematic Review

Inclusion Criteria: university; undergraduate; taught postgraduate; all degree years; any discipline or multidisciplinary; project or team-based activity; full papers; available at UoL; English language version available; any date

Exclusion Criteria: FE/Community college; research postgraduate; taught course; conference abstract; review article; not available at UoL; not available in English