

## THE ROLE OF STATISTICS TO ADVANCE THE SUSTAINABLE DEVELOPMENT GOALS

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*With less than ten years underway to achieve the United Nations Sustainability Goals (UN SDGs), the urgency to accelerate our collective efforts has never been greater. Given their critical stand in educating future generations of leaders, business schools have been tasked with significant responsibility in making progress towards the finish line. Business schools have proactively integrated the SDGs into the curriculum by developing specific courses. Still, the inclusion of the SDGs in core and elective courses is lacking. This paper addresses this gap by providing two illustrative examples of teaching SDGs in a first-year business statistics unit. Through contextual learning, students develop familiarity with the SDGs, identify their interconnectedness, and become more aware of their future roles as business participants and leaders in achieving the SDGs. Our examples can provide strategies for others to adopt or adapt to integrate the SDGs into their courses.*

### INTRODUCTION – UN’S SUSTAINABLE DEVELOPMENT GOALS AND STATISTICS

There is an increasing consensus that sustainability should meet the present needs while safeguarding for the future generations to meet their own needs (World Commission on Environment and Development, 1987). It is a global issue and thus requires a global response. Towards this aim, the United Nations (UN) proposed an ambitious framework, the *Sustainable Development Goals (SDGs)*, consisting of 17 goals, aiming to reduce poverty, protect the planet, and ensure peace and security, set to reach the global community by 2030. While attaining the goals require universal and collective efforts from all stakeholders, the SDGs urge businesses to “apply their creativity and innovation to solving sustainable development challenges” (United Nations, 2015).

Business schools (can) play an indispensable role in responding to this demand, given the annual multitude of business graduates internationally, whose career paths can encompass nearly every sector and industry (Weybrecht, 2017). If business alums can think and act with the triple bottom line in mind, it will lead to societal changes at an astonishing pace reaching all parts of society. Besides “bearing a profound, moral responsibility to increase the awareness, knowledge, skills and values” of their students (Cortese, 2003), contributing to research and thought leadership (Weybrecht, 2022), business schools offer a platform for discussions, knowledge dissemination and the development of partnerships (Arruda, 2017; Weybrecht, 2017; PRME, 2020). With less than ten years to the 2030 agenda, business schools can be the true enablers in moving forward realising the SDGs at the speed and scale required.

Statistics, a quantitative language that underlies business analytics and insights, is a powerful tool for developing sustainability literacy (Kinzer, 2021). UN also has echoed that understanding data and statistics can facilitate more effective SDG decision-making. Given that *statistics* is a core component of most business school curricula, there is a significant opportunity to adopt contextualised learning of the SDGs in teaching (business) statistics. Integrating authentic contexts, such as the SDGs, into statistics education aligns closely with the constructivist theory learning, which posits that students construct knowledge based on their experiences (Neumann, Hood & Neumann, 2013). The application of contextualised learning has been gaining popularity in the field of statistics education, especially in the non-science degrees where many students disengage from the outset due to statistical anxiety or fail to appreciate the course relevance (Onwueguzie & Wilson, 2003). When students begin to integrate their contextual knowledge with their statistical knowledge, it strengthens their statistical reasoning leading to informed decision making (American Statistical Association, 2016; Bilgin, Prvan, 2021; Bilgin, Powell, Richards, 2022; Dierdorff et al., 2011; Pfannkuch, 2011). Incorporating real-world problems that hold relevance to students’ daily life and future careers enables them to perceive the significance of the (foundation-service) statistics unit within their majors (Bidgood 2010). Using the SDGs as the context for statistical learning enables business students, the future business leaders, to navigate in the big data era to learn how to make agile and efficient decisions to achieve a sustainable and fair future.

This paper aims to demonstrate the integration of sustainability literacy within the first-year curriculum of a Bachelor of Commerce (BCom) degree, specifically by embedding it into a large service statistics unit with yearly enrolments of over 2000 students. The BCom is offered by a business school, accredited by the AACSB, in metropolitan Sydney, Australia. The first-year business statistics unit is one of the first pillars that the school uses to map the SDGs, followed by other units in the second year, culminating in a BCom capstone unit in the third year. Through a whole school approach, the business school is committed to align its initiatives with the SDGs through education, research, operations, and governance.

## BACKGROUND TO CURRICULUM CHANGE

Sustainability as a concept in our institution has been discussed for more than a decade. There have been initiatives to embed sustainable thinking and behaviour into our campus life and later into the curriculum. While there has been little resistance to these ideas, the uptake of revising the curriculum to ensure sustainability becoming an integral component rather than a mere addition has been slow. This can be attributed to the challenges requiring academics to step out of their comfort zone to re-evaluate the content and pedagogical approaches, necessitating a comprehensive reflection on both how we teach and what we teach. As part of the Business School accreditation with the AACSB, they are required to embed various transferrable skills into their first-year foundation curriculum. The business statistics unit was entrusted with the responsibility to promote sustainable thinking, presenting an opportunity for initiating unit redesign.

The curriculum revision process commenced by formulating the learning outcomes, content, activities (i.e. lectures, tutorials and computer laboratory classes) and assessments. Additionally, careful consideration was given to determining the most effective pedagogical approaches for integrating the SDGs into the unit. During lectures, we introduced the SDGs framework to set the scene, highlighting their relevance to the lecture topics, such as summarising data graphically and discussing statistical knowledge with students' employability skills. We adopted an incremental change to some learning activities.

We adopted a deliberate approach to showcase the practical application of statistics in real-life scenarios that address the concerns and issues highlighted by the SDGs, resonating with our students. To achieve this, we integrated relevant resources from the UN SDGs to create contextual examples. For instance, in the lecture, we introduced the concept of a 95% confidence interval for population proportions, enabling students to analyse the public attitudes and perceptions towards renewable energy. This example was further explored and discussed during the tutorial to reinforce student learning (see example 2). In contrast to teaching students how to calculate probabilities using normal distributions with arbitrary numbers, we constructed the examples using a UN report on the state of fisheries and aquaculture (see example 1). This approach to teaching probability enabled students to grasp abstract statistical concepts within the context of sustainability.

Moreover, we replaced the widely used *Roller coaster* data set, which was small and failed to enthuse students, with a well-crafted *Countries* data set. This data set was constructed by merging publicly available data from various sources, providing comprehensive information about countries worldwide. It contains variables such as *region*; *CO2 emissions, tonnes per person in 2018*; *Life Expectancy in Years in 2018*; *corruption perception index*. By exploring this dataset graphically and numerically in the context of UN SDGs through comparing countries, students were able to learn about the world they live in.

To ensure the relevance and timeliness of our assessments, we have incorporated the yearly SDGs reports. Some of our end-of-session assessment questions are written in the context of these reports. This approach enables us, as educators, to stay up to date with the evolving landscapes of the SDGs and present our students with current SDGs contexts. This approach allows us to conclude the unit by providing students with a comprehensive and timely understanding of the SDGs, scaffolding students' engagement with these goals in their majors.

The following sections present selected learning activities and assessment tasks demonstrating how contextualised learning of the SDGs through analysing real-world data sets and contexts can help students to appreciate the relevance of statistical knowledge and technical skills such as Excel. The acquisition of transferrable skills occurs when students start to conceptualise how statistical knowledge can help with tackling the challenges associated with the SDGs. More importantly, instructors' rationale

in designing these learning activities are provided to facilitate the readers and practitioners to comprehend the underlying principles guiding the redesigning, facilitating the modification and adaptation of these approaches to suit any learning and teaching practices.

## EXAMPLES OF LEARNING RESOURCES

### *Example 1: United Nations Strategic Development Goal 14: Life Below Water*

In this exercise, students practice calculating probabilities for the Normal distribution as a precursor to later work on inferential statistics. The exercise was chosen to be easily understood by students from a range of backgrounds and cultures. It does not require scientific or technical terminology, nor does it rely on an understanding of local conditions, so removes these as potential inhibitors to comprehension. Students are given a context from the United Nations Strategic Development Goal 14: Life Below Water (UN Goal 14). The exercise references a report from The Food and Agriculture Organization of the United Nations: The State of World Fisheries and Aquaculture (United Nations 2018). An excerpt from this report establishes the scenario to be explored: “The fraction of marine fish stocks fished within biologically sustainable levels has exhibited a decreasing trend from 90.0 percent in 1974 to 66.9 percent in 2015.”

In this exercise, students study the length of fish in a population. The rationale is provided as: “Larger fish must also be left in the population as larger female fish lay many more eggs than smaller female fish.” This statement paraphrases the New South Wales Department of Primary Industries’ findings into the management of commercial and recreational fishing (Stewart et al. 2010). The exercise is structured as a series of probability calculations for the Normal distribution. Students are asked to consider the horizontal axis as the values of a random variable which is the length of fish, assuming a mean of 34cm with a standard deviation of 11cm in this population, The structure of the exercise provides a useful reference for typical probability calculations.

For some students, the concept of the distribution of a random variable is difficult. These students are encouraged to think in ‘every day’ terms and to visualise this distribution ranging from smaller fish through to longer fish. The horizontal axis can be related back to the more familiar idea of the number line to help students envisage the concept of a distribution in tangible, rather than abstract terms. The methodology suggests that a student draw a diagram to express the problem to be solved (Figure 1). With encouragement, all students can sketch the Normal distribution and mark the values of interest. This increases student confidence that they can make progress towards a solution. Students enjoy working on this exercise in groups. Members of the group can draw diagrams, compare their results, then use the diagrams as a way of building a solution together through peer learning.

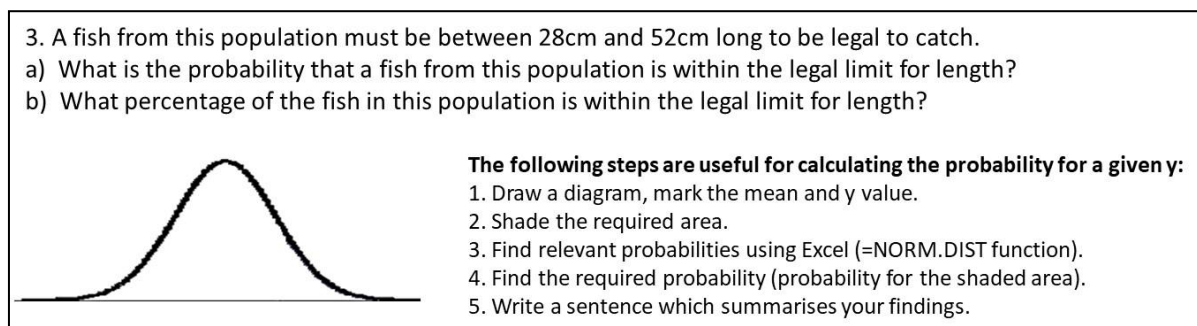


Figure 1. An example of normal probability calculation question in UN SDG 14 context

This example could be further developed in other aspects of statistical learning. Students could use a random sample data set from this population to calculate descriptive statistics, create appropriate graphical displays, and later for inferential statistics such as comparing length of fish species across regions. Students could examine original research; how that research is translated for a general audience, and how the research is enacted in legislation. Other related studies could form the basis of exercises in data interpretation and infographics.

*Example 2: United Nations Strategic Development Goal 12*

The United Nations Sustainable Development Goal 12 relates to responsible consumption and production. “Worldwide consumption and production - a driving force of the global economy - rest on the use of the natural environment and resources in a way that continues to have destructive impacts on the planet.” (UN Goal 12). One of the initiatives toward achieving this goal is to replace the plastic shopping bags with better alternatives. Not so long ago, this was a concern worldwide and possibly it is still a concern in some countries. One of the big supermarket chains in Australia, Woolworths, replaced the single use plastic shopping bags with 15 cent reusable plastic shopping bags in 2018 and by now there is no single use plastic bags supplied in their stores. At the time of this change, there were articles published in daily newspapers based on surveys of customers such as

*“Only one in five Australians disagree with the decision by Coles and Woolworths to ban single-use plastic bags, but more than half have stockpiled bags to use after the ban comes into effect. Based on a random survey [...] found 71% agree with the decision...”* (Chung 2018).

With this above news article, we pose the research question: “What is the true proportion of Australians who support the decision by Coles and Woolworths to ban single-use plastic bags?” We ask students to construct a 95% confidence interval for the true proportion of Australians who agree with the decision by Coles and Woolworths to ban single-use plastic bags. Assuming a random and representative survey was conducted, we suggest that they should check whether it is possible to make Normal Distribution approximation to Binomial Distribution before making any calculations. This context in a tutorial class, where the aim is to have discussions within the classroom to work towards a solution, triggers conversations regarding the changes we have seen in the attitudes of shoppers to the type of carry bag they would use for shopping and the adjustments that both the shopper and the store have made. Undoubtedly, statistical literacy and critical thinking are important skills identified by the employers. Such context allows students to think about the problem from their own perspective and see the importance and usefulness of statistics to the question(s) at hand.

Although many of our students would have been turning teenagers just around the time Woolworths moved away from single use plastic bags, they would have witnessed the change of their families shopping habits (bringing their own bags instead of expecting bags to be given to them). In addition, the situation is still evolving with supermarkets and other retail outlets still trying to educate customers in terms of supplying their own carry bag. As a current real-world (authentic) context, our students tend to show interest and realise that the skills they are learning in statistics are being used to monitor the change in attitudes of shoppers.

Recently, Woolworths made a press statement that “Eight in every ten Woolworths customers already bring their own bags when they shop, and the retailer is continuing to encourage customers to bring their own bags to boost sustainability, rather than buying them in store. Woolworths paper and other reusable bags will remain available to those who need them”. With continuing development in terms of shopping bags, recycled packaging and sustainable packaging, utilising UN SDG 12 context to discuss in class and solve problems using statistics, shows the real-world application of statistics.

## DISCUSSION AND PEDAGOGICAL IMPLICATIONS

### *Benefits for students*

Our students are studying Business Statistics, some of them are majoring in Marketing or similar disciplines, it is obvious that statistics is going to be useful to their future career. More than likely, they will work in a variety of different jobs such as retail business, manufacturing, engineering companies and education. We aim to develop skills that will help our students in a wide variety of professional situations while at the same time awaken their curiosity to the world around us by using the SDG related contexts. While universities offer a variety of well-crafted sustainability-focussed courses, the decision of enrolment is at students’ discretion. In contrast, embedding the SDGs into the first-year curriculum within a non-sustainability focussed degree offers a significant advantage given its broader and more diverse student cohorts. Using real-life data and context drawn from the SDGs permits deep learning and retention of the statistical concept (Neumann, Hood & Neumann, 2013). In addition, researchers have shown a positive association between the use of the real-world data when teaching statistics and

enhanced student interest, motivation and engagement, contributing to student success (Neumann, Hood & Neumann, 2013).

#### *Benefits to society*

The global community can benefit significantly when business students graduate with enhanced literacy in statistics and sustainability development. These future employees working in small or large organisations will account for their actions when addressing global ethical issues such as destruction of the environment, corruption, and discrimination (Dean et al., 2018; Iftakhar & Bahauddin, 2018). With an increasing sense of agency, students will be proactive in leading the endeavours towards the achievement of the global sustainability.

#### *Benefits to the practitioners*

This paper demonstrates how redesigning the curriculum by utilising authentic data sets to enthuse and engage non-statistics major students in learning statistics can help by fostering the perception of the course relevance underpinning student motivation and their persistence in the unit. By incorporating contexts and data derived from the SDGs in the first-year curriculum, students are introduced to the ambitious 2030 agenda early on in their academic journey. This early exposure allows for greater interactions both in numbers and in intensity with the framework before assuming full responsibility advancing the SDGs.

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