

INCORPORATION OF SUSTAINABLE DEVELOPMENT GOAL 4 IN BIOLOGY CURRICULUM DESIGN: A CASE STUDY

(Penggabungan Matlamat Pembangunan Lestari (SDG) 4 dalam Reka
Bentuk Kurikulum Biologi: Satu Kajian Kes)

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Abstract

Curriculum design needs to be undertaken at both programme and subject level. The programme structure needs to enable the graduates to also acquire integrative biotechnology laboratory skills and employability skills. Module-specific knowledge and skills are essentially important, but they are meaningless on their own. This paper focuses on the review of one subject, i. e. BIO 2134 Instrumental Analysis, with the aim of examining the targets in Sustainable Development Goal (SDG) 4 - particularly Target 4.4 on increasing the number of people with relevant skills for financial success (employability skills), and Target 4.7 on education for sustainable development and global citizenship – and how they can be better achieved. We focused on the learning outcomes (LOs), assessments, and teaching and learning activities. First, we refined the 4 LOs to 3 to reduce overlaps and repetitions, as well as to improve students' assessment workload. Secondly, we expanded the scope of one of the assessments by including the element of entrepreneurship into the research proposal. The study can provide very useful information for a larger scale review of the curriculum redesign to probe if similar changes can be done for other modules in the programme to be aligned with the SDGs agenda and its action of framework.

Keywords: SDG 4, curriculum design, learning outcomes, assessments, employability, higher education

Abstrak

Reka bentuk kurikulum perlu dijalankan di peringkat program dan subjek. Struktur program biologi seharusnya membolehkan graduan memperolehi kemahiran makmal bioteknologi yang menghasilkan kemahiran pekerjaan. Pengetahuan dan kemahiran khusus berkaitan dengan modul adalah sangat penting tetapi tidak akan bermakna sekiranya kedua-duanya tidak bergabung. Kertas ini memberi tumpuan kepada kajian satu subjek, iaitu BIO 2134 Analisis Instrumental, bertujuan mengkaji sasaran dalam Matlamat Pembangunan Lestari (SDG) 4 - khususnya Sasaran 4.4 untuk meningkatkan populasi yang mempunyai kemahiran yang berkaitan untuk kejayaan kewangan (kemahiran kelayakan pekerjaan), dan Sasaran 4.7 untuk pendidikan bagi pembangunan lestari dan kewarganegaraan global - dan bagaimana ia boleh dicapai dengan lebih baik, sejajar dengan SDG 4. Hasil pembelajaran (LO), penilaian, dan aktiviti pengajaran dan pembelajaran telah dikaji semula dan dipinda sewajarnya. Pertama, hasil pembelajaran telah dikurangkan daripada 4 kepada 3 bertujuan untuk menghapuskan pertindihan dan pengulangan, serta mengurangkan beban penilaian pelajar. Kedua, skop salah satu penilaian telah diperluas dengan memasukkan unsur keusahawanan ke dalam cadangan penyelidikan. Pendekatan pembelajaran berasaskan masalah menjadi satu kriteria yang dinilai dalam cadangan penyelidikan kerana

ia merupakan kebolehan yang penting untuk pelajar. Kemahiran penyelidikan dan penyelesaian masalah adalah kemahiran boleh pindah yang penting di tempat kerja. Unsur biokeusahawanan akan membolehkan pelajar-pelajar menerokai peluang perkhidmatan komersial. Kebolehan menyelesaikan masalah perniagaan bioteknologi yang sedia-ada juga meningkatkan kemahiran pekerjaan pelajar dan ini membantu untuk memenuhi permintaan pasaran. Kajian ini dapat memberikan maklumat yang bermanfaat untuk kajian semula rekabentuk kurikulum dalam skala yang lebih besar untuk menyiasat sama ada perubahan serupa boleh dilakukan untuk modul-modul lain dalam program tersebut agar selaras dengan agenda SDGs dan kerangka tindakannya.

Kata kunci: SDG 4, reka bentuk kurikulum, hasil pembelajaran, penilaian, kemahiran pekerjaan, pendidikan tinggi

1.0 INTRODUCTION

The United Nation (UN) adopted a 2030 agenda for Sustainable Development on 25 September 2015. There are 17 Sustainable Development Goals (SDGs) in the 2030 Agenda (Appendix 1), including health, education, social protection, economy, climate change and conservation of environment, ensuring that no one is left behind. The purpose of SDGs is to achieve a better and more sustainable future for all, economically, socially and environmentally. SDGs' blueprint addresses the global challenges such as peace, justice, poverty, inequality, climate change, and environmental degradation. The partnership between governments, the private sector, civil society, and citizens is vital to ensure a sustainable and better planet for everyone now and for future generations. In relation to that, quality education can be a vehicle for achieving sustainable development. Hence, efforts are needed to improve access to education and the quality of the education that is provided. By making quality education affordable and accessible, we are reaffirming our commitment to achieving the SDGs goals for an economically secure, ecologically stable and socially prosperous world now and in the future (Ferrer-Estévez & Chalmeta 2021).

Sustainable development goal (SDG) 4 states that the basis to creating sustainable development is by obtaining inclusive and quality education. Access to inclusive and equitable quality education can help equip state citizens with the necessary tools such as lecture delivery and assessment tool to provide innovative solutions to the world's greatest problems, thus improving the quality of life. There are 10 targets and 11 indicators stated in SDG 4 (Appendix 2) comprising different aspects of education and achievable at the appropriate level. Universities play a very important role in educating and navigating students correctly towards creating a sustainable society. The integration of Sustainable Development Goals into higher education shows the importance of engaging tertiary students in achieving SDGs. Thus, the implementation of sustainability-centered education programs to equip students with the desired skills is important - not only for the betterment of the students but also the employers who seek positive returns in terms of profitability, resulting in overall economy growth.

Sunway University (SU) is a university in Malaysia that is committed to the United Nation's 17 SDGs through education and research to build a sustainable future for all, by providing affordable education (Target 4.3) through scholarships from the Jeffrey Cheah Foundation (Target 4.B). SU itself strives to be inclusive by eliminating discrimination through its policies and through provision of facilities for staff and students with disabilities (Target 4.5). It is committed to staff development and training (Target 4.C) to ensure quality education is provided by qualified teaching staff who are competent in designing curriculum that is aligned to SDG 4.

Sunway University offers various home-grown degree programmes such as Business, Finance, Marketing, Management, Art and Design, Hotel Management, Communication, Computer Sciences, Psychology, Medical Biotechnology and Biomedicine. This paper focuses on a degree programme that the first author is teaching on, which is the BSc (Hons) Medical Biotechnology. The programme is offered under the Department of Biological Science, School of Science and Technology. As a department that was setup in 2015, it is considerably young; the first batch of BSc (Hons) Medical Biotechnology students graduated in 2017. In March 2020, the alumni records showed that all of the graduates were employed, but not all were employed in the field of Biotechnology. For this reason, a review of the curriculum design was important. We needed to examine whether our graduates were equipped with employability skillsets for the field and how we could improve the programme while it was still young. According to Mantze and Yorke (2004), employability skillsets are skills, knowledge and attitudes that will make graduates have more probability to be employed and be successful in their chosen jobs. This benefits the graduates themselves, their employers, community and the economy (Yorke, 2006). Employability skillsets expected by employers are good communication skills, flexibility, decision-making, problem-solving, teamwork, digital skills, creativity and critical thinking skill and professionalism (Marope, Griffin, & Gallagher, 2017).

The BSc (Hons) Medical Biotechnology is a three-year degree programme validated by Lancaster University, UK. The curriculum contents were designed and developed by a group of experienced professors and faculty members who were actively involved in research but had minimum entrepreneurial experience. This resulted in a programme that was more focused on a research-led career pathway. Although this is beneficial for students inclined in that direction, it might not be for others. Not everyone is interested to undertake postgraduate studies or capable of undertaking a master's degree or a PhD. Furthermore, graduates who are solely rich in research skills but lacking in employability skills may adversely affect biotechnology companies as these companies are not getting candidates with the skill sets that meet market demand. In the long run, this will have an impact on the companies' profitability and the nation's economy. [3].

When we design a programme, the learning outcomes and curriculum contents for the programme and the subjects within the programme are written and designed with close reference to three learning domains, namely the cognitive, psychomotor, and affective domains, to ensure holistic development of students. This applies to the BSc (Hons) Medical Biotechnology programme. To further ensure students' holistic development, the programme also includes 2-credit hour modules that focuses on community development such as MU4 2432 Community Service. This module aims to create awareness of civic responsibility in students and their role in supporting our local community. The community service activities may take place in public institutions such as hospitals, non-profit organizations, social welfare homes, animal shelters as well as organizations which champion the environment. In this module, students volunteer to help the needy, solve environmental problems (such as beach cleaning) support refugee relief activities, and participate in societies and co-curricular activities. They also gain the opportunity to provide peer tutoring services to academically weak school students (with/without wages). However, the drawbacks are that very limited credit hours are involved, and students may not see modules like Community Service as a good opportunity to gain their employability skills, as they perceive that only field-based subjects enable them to gain employability skills. Thus, to ensure we support students' development of employability skills, some changes in the modules' learning outcomes, assessments and teaching and learning activities in the classroom may be needed. Such changes will also help students gain distinctive experience from the module. The incorporation of assessment strategies that can

promote employability skills, such as peer assessment, group projects, case studies and problem-based learning, will also help to enrich learning derived from the module.

The BSc (Hons) Medical Biotechnology degree programme comprises of module-specific knowledge and laboratory skills. It also incorporates aspects of instrumental analysis and bioinformatics, in addition to the more traditional modules such as human anatomy, cell biology and molecular biology. Module-specific knowledge and skills are essentially important; however, they are meaningless on their own. The programme structure needs to enable the graduates to also acquire integrative biotechnology laboratory skills and employability skills (Hughes, 2002). Hence, a curriculum design review needs to be undertaken at both programme level and subject level.

However, this paper focuses on the review of one subject, i. e. BIO 2134 Instrumental Analysis. Specifically, this subject review explores how targets in SDG4, particularly Target 4.4 on increasing the number of people with relevant skills for financial success (employability skills), and Target 4.7 on education for sustainable development and global citizenship can be better achieved. The focus of the curriculum review for the subject were the learning outcomes (LO), assessments, and teaching and learning activities. The study could provide very useful information for a larger scale review of the programme curriculum to explore if similar changes would be needed for other modules in the programme.

2.0 METHOD

In this case study, a curriculum review of a subject, i. e. BIO 2134 Instrumental Analysis was conducted. The purpose of the review was to assess how the curriculum could be enhanced to support the achievement of Target 4.4 and Target 4.7 in SDG 4. An analysis of the existing curriculum was carried out involving the subject's learning outcomes (LOs), assessment methods, and teaching and learning activities. This study was closely guided by senior educational developers from the university's Academic Enhancement Division.

3.0 RESULTS AND DISCUSSION

3.1 Module content analysis

BIO 2134 Instrumental Analysis is a 4-credit module that covers the theory and practical applications of research methods used to analyze biological and chemical samples, including hands-on practice with equipment used in biotechnology laboratories; there is an emphasis on chromatography, mass spectrometry and microscopy. These instruments are used to measure physical properties to distinguish the constituents and the concentrations in the unknown sample. Instrumental analysis will continue to grow as new methods and new instruments are developed to increase efficiency and automation. It is important to point out that in some cases, classical analytical techniques are still the most accurate way to measure an unknown. However, for other cases, the advantages obtained from instrumental methods far outweigh those of classical techniques. The instruments covered in this module are up to date as they comprise high-end instruments that are used in analysis in the field of medical biotechnology. Thus, no change is required on the syllabus as they are up-to-date.

3.2 Findings on learning outcomes (LOs)

At the point of the review, i. e. in 2020, the module had already been taught 4 times. The existing 4 learning outcomes meant a considerable workload on the students. This is because the Malaysian Qualifications Agency (MQA), the regulatory body that oversees the quality of provision by Malaysian higher education institutions stipulated that all LOs had to be assessed summatively. Thus, it was important to reduce the LOs from 4 to 3 to improve students' assessment workload. This also allowed for the opportunity to refine the remaining LOs to reduce overlaps and repetitions, as well as improve their clarity. The changes to the learning outcomes and assessment methods after the subject review are reflected in Table 1 below.

Table 1 BIO 2134 Comparison of Old and New Learning Outcomes and Assessment Methods

No.	Old Learning Outcomes (2019 and before)	Old Assessment Methods	Revised learning outcomes: (2020)	Revised Assessment Methods
1	Explain the theoretical principles, operation and sample preparation for scientific instruments.	50% final exam 20% mid-term test	Outline the theoretical principles, operation, and sample preparation for scientific instruments.	50% final exam
2	Explain the fundamental basis of measurements and its dependence on molecular structure, the physical chemistry of underlying interaction of light and matter, and the chemical interactions among molecules that are the driving forces for analytical separations.	15% practical	Perform experiments using appropriate instrumental methods of analysis to problems in biotechnology which are practically applicable to the real-world problems.	20% practical
3	Select, describe, analyse, and apply appropriate instrumental methods of analysis to problems in biotechnology, practical applicability of measurement methods and applications to real-world problems.	15% research proposal	Propose an analysis using the relevant instruments with the interpretation of data by acquiring profound knowledge of both the theory and practice underlying a measurement system and any limitations involved.	30% research proposal
4	Identify the best instrument for a particular type of information needed, perform typical analyses and interpret the data from the instruments by acquiring profound knowledge of both the theory and practice underlying a measurement system and any limitations involved.			

3.3 Findings on assessment strategies

The revised module assessments constitute of 50% final exam and 50% coursework. Previously, the assessments for the module constituted of 50% final exam, 20% mid-term test, and another 30% allocated to coursework, which included 15% practical work and 15% for research proposal (Table 1). In line with the intention to reduce students' assessment workload, the mid-term test was removed, but the final exam remained at 50%. The mid-term test was eliminated completely to reduce the cognitive component but to increase psychomotor and affective components. By increasing the psychomotor and affective components, student will be able to demonstrate their academic achievements through different ways, thus promoting a well-rounded learning experience that can improve achievement of learning outcomes.

For the coursework, the practical component has been increased to 20%. This is because there are 2 sub-components in practical: (1) field trips and (2) experiments. Field trips form part of the practical component for this module as they greatly impact students' learning by helping them relate what they learn in the classroom to the real-world. Field trips offer good opportunities to students to develop knowledge and practical skills outside the classroom (Barker, Slingsby, & Tilling, 2002), which become added value to their classroom learning and experience (Barker, Slingsby, & Tilling, 2002; Knapp, 2000; Rudmann, 1994). Furthermore, through the authors' teaching experience and reflection on student feedback, field trips help students make a connection between what they learned in the classroom, what they learn from the textbooks and what they learn from their engagement in relevant activities in real settings. Consequently, these reinforce their learning, enabling them to demonstrate their achievement of the learning outcomes in their final exam. At the time of the review, field trips conducted include visiting instrumental lab in another university. The field trip experience for future cohorts could be expanded to biotechnology-related companies such as clinical or diagnostic labs or instrumentation labs.

The research proposal component has also been revised with an allocation of 30% of assessment marks, instead of 15%. Previously, the focus of the research writing proposal was only on natural product drug discovery, with the choice of disease made by students. It was set as group work in order to support the development of important skill sets including oral communication, problem-solving, decision-making, teamwork and leadership skills. In Research Proposal Part 1, students are expected to produce an abstract containing 500 words to briefly communicate their idea. In Research Proposal Part 2, students are expected to produce a full proposal containing 2500 words comprising of Introduction, Literature Review, Methods and Instrumentation, and The Implication of Research to the Community/Society. These are still maintained in the revised version of the subject. However, to improve employability skills, some entrepreneurship elements will be incorporated in the module syllabus, particularly, in the research proposal. In general, the employability skills of our students for an entrepreneurial perspective had been overlooked (Fitzgerald, 2016) and it is important that this is addressed. The inclusion of entrepreneurship elements and employability skills help address the needs of students who are in the programme but are not interested to venture into research-based career paths. This is an important issue that students and parents have raised in past conversations. The incorporation of the entrepreneurial element could be achieved by expanding the scope of the research proposal title to a business proposal. For instance, students can come up with a research proposal to identify a bioscience problem worth to be researched on and developed into a business plan, or students can come up with a proposal to provide commercial service or product as a solution to the problem in the community. Alternatively, students can develop a proposal to commercialize a biology-related technology or piece of biotechnology research in an existing enterprise. This ensures that learning is more inclusive.

With the expansion of the scope of research proposal to include the entrepreneurial element, students will have more room to develop new ideas, explore different areas and develop different perspectives in the field of biotechnology. Subsequently, this will help them to creatively generate new ideas in their research proposal writing. They can also explore the latest technology available without limiting themselves to solving bioscience research-based problems. This will significantly benefit students who are uninterested in research, particularly those who may perceive literature review as irrelevant to their interest, allowing them to focus on what they may perceive as the more practical and interesting part of the project. The problem-based approach incorporated into the research proposal assessment brings value to students. Such research and problem-solving skills are transferrable to the

work place. The entrepreneurship elements whereby students explore the possibility of providing commercial services and solving existing biotechnology-enterprise problems may also improve students' employability skillsets which meet the market demand.

Additionally, the incorporation of problem-based learning in assessments, using world or topical issues (such as COVID-19) addressing solutions and challenges from the world's perspectives often make the assessment task come alive, making it more meaningful and students participating more actively. Students' engagement and learning will be enhanced as problem-based learning focuses on minds-on, hands-on learning organized around the investigation and solving of real-world problems (Akca, 2009).

3.4 Guest speaker series as part of teaching and learning activities

Teaching and students' classroom learning can be enhanced by including a guest speaker series (research and industrial) whereby research and industry experts in the field of biotechnology are invited to speak to the students on relevant topics. This could be done as live events or pre-recorded, a speaker at a time or in the form of webinars. With proper planning, this is relatively easy to achieve, especially since webinars have received increasing attention and have become a popular method for sharing knowledge and connecting people from different locations (Gegenfurtner & Ebner, 2019; Knipfer et al., 2019).

4.0 CONCLUSION AND OUR PERSPECTIVES

SDG4 Quality Education can be better achieved if the curriculum of the BSc (Hons) Medical Biotechnology programme is reviewed by carefully examining the targets in SDG4. A complete programme review, similar to what has been undertaken for one subject, i. e. Instrumental Analysis which is the focus of this paper, will ensure that the programme is better aligned to achieving the targets of SDG 4 both at programme and module level, thereby leading to the programme graduates meeting the employers' needs. To do so, teaching faculty need to share the vision of improving the quality of education, increasing inclusivity and enhancing graduate quality and employability, and are guided in this by sustainability guidelines of the SDGs and the university. This will enable both faculty and students to work together to develop appropriate curricula and pedagogies, build the competences needed, pursue the opportunities and overcome the constraints, and evaluate progress towards the intended goals.

To better achieve both Target 4.4 on increasing the number of people with relevant skills for financial success (employability skills), and Target 4.7 on education for sustainable development and global citizenship as mentioned earlier, young alumni entrepreneurs could be appointed as students' industry mentors in the near future. However, the department is still young as the first batch of students graduated in 2017. As such, there is yet to be a successful alumni entrepreneur who can inspire students to develop and start their own enterprise. Meanwhile, some efforts from the students are needed to be employed and succeed in the working world. Students also need to play an important role so that they can gain the appropriate skill sets that meet the demand of the workplace. They can and should explore opportunities outside their degree course, join some extracurricular activities or volunteer programmes, take up relevant part-time jobs that will help them develop the desired skill-sets during their semester break or free time. They should do this as early as possible when they join the university. Over time, their increasing knowledge and skills will boost their confidence level and their personal commitments.

In conclusion, both educators and learners play an important role in achieving SDG 4. Educators need to help students prepare for their career by supporting the development of their employability skillsets that meet the employers' demand, through appropriate learning and assessment activities that are incorporated into individual modules and the programme. This is not someone's job, but rather, everyone's.

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