

From general sciences to applied sciences: some notes

Opinion

Sometimes, many people especially university students do not focus on the subjects or courses or even program such as biology, physics, chemistry and mathematics as their university's major or bachelor program since these subjects are nothing new to them since their school days curriculum. Therefore, the objective of this short review paper is to review and highlight the importance of the General Science (GS) to the application of the knowledge of GS or Applied Sciences (AS) such as biotechnology, at the university level study.

According to Merriam-Webster's Dictionary, GS is defined as "A subject or course of study in school or college in which the elements of several sciences are studied." The elements of several sciences include knowledge of biology, physics, chemistry and mathematics. Whitman¹ highlighted the importance of GS in education. In an undergraduate GS course, Kim et al.² used active learning modules by incorporating group-based learning with authentic tasks, scaffolding, and individual reports. Their study suggested that the active learning strategies employed in the study were useful to promote students' critical thinking. Therefore, the fundamental knowledge of GS can be applied to foster a mixture of learning skills including students' critical thinking.

In general, AS can be interpreted as the application of existing scientific knowledge to practical applications. This can be exemplified by technology or inventions. Applied science is the use of scientific processes and knowledge as the means to achieve a particular practical or useful outcome. This includes many AS related fields, ranging from biotechnology, environmental sciences, bioengineering, biomedical sciences, and health risk assessments to even social sciences. For example, GS (fundamental biological processes) are important to research training for the physician scientists.³

The earliest citation on AS was perhaps the plant analysis that was considered as an AS related field of study by Des.⁴ Meanwhile, perhaps, the best early review on Applied and Pure Sciences (APS) was that reported by Karrer⁵ from Nela Research Laboratories, USA. The Faculty of Science (FS) of Universiti Putra Malaysia (UPM), currently under the deanship of honourable Prof. Dr. Mohd. Basyaruddin Abdul Rahman (since 2017-), is one the best example of a legacy of APS in Malaysia. The FS of UPM consists of four major departmental studies including biology, chemistry, physics and mathematics. This clearly typifies the major scopes in the study of GS to APS.

Based on hotcoursesabroad.com searched on December 28, 2018, a comparison of number of institutions in Malaysia, Singapore, Japan, Asia and all countries offering on-campus GS and APS courses is presented in Table 1. It is clearly shown that numbers of institutions in APS courses are higher than those in GS courses. This is generally expected since the GS courses are offered at pre-university study or basic science programs at early stage of bachelor degree studies in most universities. Most the university programs usually offer courses for applied knowledge in GS study.

In this review paper, keyword 'General Science' was put to find the available papers based on Scopus database, searched on December

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28, 2018. There are a total of 252 papers with GS as part of the article title. Similarly, with the keyword 'Applied Sciences', there is a total of 919. However, with keywords 'Applied and Pure Sciences', there is only 1 paper found. The higher number of papers in APS than GS is supportive of the outcome searched based on hotcoursesabroad.com. This suggests that most research papers are based on APS rather than GS. Again, this is generally customary. For instance, knowledge of biomonitoring heavy metal data in edible shellfish is baseline information for public knowledge. The assessment of human health risk (HHR) of heavy metals in the edible marine mussels is an example of the application of the heavy metal levels for the human benefit.⁶ Therefore, heavy metal data is GS while HHR of heavy metals in the marine mussels is AS. Similarly, zinc levels in the vegetables are GS while HHR of zinc in the vegetables are AS.

Table 1 Number of institutions in Malaysia, Singapore, Japan, Asia and all countries offering on-campus General Sciences and Applied and Pure Sciences courses

	General sciences	Applied and pure sciences
Malaysia	53	65
Asia	113	178
All countries abroad	1100	1703
Singapore	4	18
Japan	13	14

Source: hotcoursesabroad.com searched on December 28, 2018

The critical thinking ways trained during GS courses are critical exercises. They are stepping stones and fundamental knowledge for any undergraduate to pursue a postgraduate research in a focused and expert field of research study. The APS courses are important for any innovative and creative study in a narrowed down or specialized scope of research study. A patent from research work is an example of APS. Environmental engineering and medicine are examples of AS because they put the existing knowledge of GS into practice and daily application for the benefit of human welfare at large.

Biotechnology is definitely within the group of AS. Biotechnology can be simply defined as the broad area of biology involving living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (UN Convention on Biological Diversity, Art. 2). The Organisation of Economic Co-operation and Development (OECD) defines biotechnology as "the application of

scientific and engineering principles to the processing of materials by biological agents". Biotechnology makes use of biological systems and processes to manufacture useful products and provide services.⁷ From the Scopus database searched on February 14, 2019 with the key word 'biotechnology', it is found that there are a total of 16,422 papers indexed in Scopus since 1933 until 2019. The first paper is by Anon,⁸ followed by Yllo⁹ on the meaning and purpose and Mullin¹⁰ on the concepts and applications. Biotechnology can have much effect on our environment. This biotechnology can affect our environment beneficially and adversely. According to Vallero,¹¹ there is a difference between beneficial biotechnology and the adverse effects of biotechnology, which can be seen as applications and implications, respectively. Example of beneficial environmental biotechnology is phytoremediation using plants to recover and clean up heavy metal polluted soils in order to reduce the hazard due to the toxic chemicals.

Conclusion

As concluding remarks, pure GS is an essential fundamental knowledge before university study. The knowledge has already been experienced by school children. During tertiary education in institutions and universities, the GS course is important for basic understanding to further application in science study. Perhaps, the same topic of GS course that is too unexceptional has been unattractive to many students at university levels but pure GS such as biology, chemistry, physics and mathematics are part of curriculum of the program chosen such as home science that needs knowledge and application of biological concepts such as biotechnology. We always believe that study of GS such as biology is essential and fundamental to a greater valid knowledge expansion in future postgraduate research-based study including physician scientists. Basic science subjects (or GS) are keys to our success and better life quality!

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Conflicts of interest

Author declares there are no conflicts of interest.

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