

Popularization or Population of Science and the Future

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Abstract: Science is experiencing a different model for a wider dissemination with the widely accessibility of internet today at the information age and high connectivity. This technological development has changed the daily life of peoples globally and has been mainly appraised with positive effects, but very little, if any, negative ones are being discussed, specifically on fundamental matters. In this article, I would like to present the emerging negativities and potential detrimental effects on science and its advances to be made. Popularization and population are two words chosen and used here to describe the way in which dissemination of available and accessible scientific information is being made. The new Open Access model of publication and its apparent dominance in the academic publishing market by commercial companies for publication of scientific papers are passing the threshold point and eroding the quality of science in my view. Scientific societies as the most important groups to the establishment of academic standards and to keep new science discoveries to be checked are increasingly forced to cope with the commercial publication practices in terms of speeding up the reviewing and publishing more and quickly, competing for the publishing market and profit to be made, and most importantly, compromising the academic standards. When profit is the major driving force for the publishers, including scientific societies, quality of science in academic papers is yielded to the financial interest and profit, and the purposes of publishing are not for science and its development as the goal. The role of scientific publication in our society must be checked by relevant administration of the governments and national academies together with the scientific societies so that the quality of academic publication of scientific results in science can be maintained at high confident level to serve the society in a positive manner into the future. Commercial publication is another avenue to allow more scientific results to be published in additional to journals by societies, but the relationship between them must be a quality-based judgement and decision, not a pure business competition for success to rule this market.

Keywords: Academic quality, scientific publication, science, open access, emerging research

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Science, technology and engineering have played an enormous important role in human history and today's society affecting individuals' life in an unprecedented way at multiple levels. People's living and quality of life have been tremendously lifted to a higher level through inventions and accumulation of new knowledge, and most importantly applications, transferring them into new useful products. Currently, storage, transmission and processing of information are heavily dependent upon microelectronics and the semiconductor industries from further new inventions into manufacturing. Because of this, function of our modern societies is operated efficiently through connectivity for navigation, communication and other purposes via the internet or wireless communications by satellites, from airplanes in the air to people walking on the streets. Such a high level of connectivity worldwide of today's world makes the Earth truly flat and accessible to the available information easily at ex-

tremely high speed without physical barrier if language is not the major issue. Even so, translation between them is being efficiently accomplished with a touch of a choice selection from the available menu and the corresponding text in the desirable language of choice is shown on a hand set phone or other mobile devices. Similarly, medical and health data of individuals can be collected by the service providers and any warning or attention can be sent to the persons involved on the planet anywhere around the clock. Such level of technological capability has never been envisioned previously and science plays an important role.

Science did not start to be an important part of our ancient society initially and our ancestors applied their experiences or accumulated knowledge from their practice in hunting, travelling, farming, pottery-making etc. The importance of science became more apparent in recent time of human history, e.g., astronomy, physics, mathematics, and biology

when specialization and professionals became an important part of the human society entities. As time progress further, science has been transformed from individuals doing at their own wishes at home and speed to dedicated organizations to perform the specific tasks as employed professionals to do it and also earn a living. Over time, it is a fundamental basis of all societies for further advancement and higher quality of life.

In this article based on the above and further extension, I would like to discuss the recent phenomenon with science and its development, specifically the products of science as scientific publications or papers. Publication of scientific results and findings has been a very important part of the science for development and communication. Dissemination of science has been carried out successfully by popularization of the pure scientific knowledge in scientific language that can be easily understood by non-specialized citizens. This has served the society by communicating with non-specialized citizens. Recently, a new trend is emerging in which massive production of scientific papers in a new model of Open Access to make the scientific results directly available to anybody mainly driven by commercial publication companies. Since far too many papers are being published on either similar results or pre-matured ones, 'population of science' is used here to illustrate this new phenomenon in this communication on the current development and the possible negative outcome to dilute the good quality science, which has a small number.

Early Science

Science as a way of knowing has changed fundamentally in the way of conducting it because scientists in the early day were strongly interested in discoveries and they treated it as a truly personal passion and hobby, which are very different from today's operation and management as a job to earn a living. Take Antoine Lavoisier as an example, he owned the most sophisticated analytical balance of the time and his contributions to chemistry were based on his wealth, passion, and the instrument so that he had no pressure at all for applying and securing any research grants or meeting any reporting deadlines or publishing to show he was a competitive researcher so that his job could be secured. His outputs were communicated through the scientific society as a means for dissemination of his findings, but there was no external pressure for doing it. His wife was his translator for many of his papers. He enjoyed his research hobby and, apparently with some disagreements, he is one of the most important chemists in history. In biology, Gregor Mendel is a good example to illustrate the biological science of the day, especially his discovery on heredity or genetics. It is not surprising that he had a true passion for his field experiments with peas and data interpretation in heredity over the years. He enjoyed the most in his life mainly the freedom without any pressure for producing anything as his objectives

or for securing further research funding or supporting his living. This important background condition of individuals involved has contributed to the science and its development in the past which has not been appreciated as much as they deserve to be today in the modern science culture. Because of the changes in supporting and managing the science and those who are doing science as a profession, the lack of genuine interest and/or significant freedom in academia today is eroding science and its development because the spirit of pursuing science is not as pure today as before.

Modern Science

Science in its own making has been changed and modified significantly by more defined divisions and specializations, and also organizations under different structures, namely university, research institute, industrial laboratory. There is very little chance, if any, to be a one person doing garage workshop research today to also survive. Actually, several factors play major role in the transformation of early science to today's forms as we see now, but the reality is that those involved in this profession today are selected based on their training, established record of research capabilities and publications than pure personal interest in a specific question as the driving force because personal passion for research has to be after earning a basic living to be very honest. This is similar to the echo of Virginia Wolf for being a woman to have the financial support and 'room' before her writing. When a precondition is a prerequisite for a career in science, especially crucial to living, the efforts and productivity are bases for job security, which are apparently pre-conditions before devoting into the science wholeheartedly. This crucial link between doing science as a career and proving successful to be able to continue in this profession is a real fact in today's competitive job market so that one person may be against another, not for the scientific truth, but job or living as the fundamental factor. Under such circumstance and condition, ethical misconduct issues including stealing others' ideas, sometimes even data and proposal text, manipulation of data, and multiple publications of the same or similar results are not rare cases now. As a result, an increase of re-tracking published papers and those containing manipulated images in high-impact scientific journals is on the rise, but there is no clear sign of effective elimination for the wrong doing in this profession. It is simply not the rules or regulations to those involved doing science, but the benefits, career success and glory are above the risks they are taking.

Popularization and Population of Science

Good science and fundamental breakthroughs in science are the foundations and bases for new technological development and applications, which significantly improve the quality of

our life and society wellbeing as a whole. A good example deserving mentioning here is the discovery of the DNA structure made in 1953 by James Watson and Francis Crick, which paved a new way of doing all biology subjects with fundamental changes from hypothesis to the high levels of confidence in experimental results without any comparison in the history so far. Brand new subjects in molecular biology, biophysics, and genes were established as important branches under the large biology, and classification and taxonomy of all organisms and the analysis on the origin of life have also been put on a new platform with the introduction of molecular clock molecules, though some arguments are still unresolved as in science. Biotechnological industries have become an important part of the emerging economy with the microelectronic as mentioned at the beginning of this article and they contribute significantly to medicine and health. Today, identification and confirmation of a known or a brand-new organism can be easily verified with a simple polymerase chain reaction (PCR) of a sample or without the organism of concern being the only or isolated pure culture prior to the confirmation result. Detection of the emerging Covid viruses is being efficiently carried out for mass population in public health and disease control. Similarly, early detection and screening of genetic diseases of babies are routinely conducted for pregnant women and, in addition the whole genome of any individual is readily sequenced allowing prediction of potential health issues and diseases, especially for those of genetical and family history relevance. These positive developments supported by science and discoveries have illuminated the modern society with high quality of life and enjoyment of extended life expectancy with good reasons.

Science remains to be a major pillar to our society and activities. It is a profession for many involved in universities, institutes, and research laboratories without mentioning the millions serving the supportive roles in the making of science on a daily basis. Science used to be conducted by the fewer of our society long-time ago because of their strong passion, interest and accumulated wealth as prerequisites. There were also some who did it successfully because of the financial supports of personal nature and patronage available, but there were no channels of open applications of research fund or organization to administer such activity. Only after different scientific societies were formed and made their significant contribution and role to play in society, national and international influence, public funds are the regular sources available to support such activities on a competitive basis. Since the fund is public in nature, the administrative management and monitoring become part of the operation of science in addition to the execution of the contents by the key members involved directly. This new introduction of an extra-layer of management to the conducting of science puts job security and available financial support before making any scientific investigations, which is very different from the requirements in the early day science of personal nature (Figure 1). In actual practice, the new career or professional nature of those

who are doing it has changed the original nature and meaning of science very differently, the passion and the research curiosities or questions.

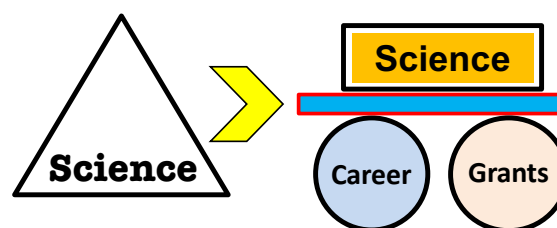


Figure 1. A transformation of doing science from pure passion for science initially (*left triangle*) to the currently requirements of job and grants to support the scientific activities (*right side*).

At the same time, as education has been widely accepted for an increasing fraction of the population in society, frontier science and discoveries are communicated both by those made the findings and also others who are committed to make the scientific finding to be more accessible to the general population using an easily understanding language. This process of popularization of science plays a very positive role in promoting science understanding to our society and transmitting the discoveries by professional scientists to people who are involved directly or indirectly because of the nature of science using public fund to serving the society. Stephen Gay Gould was one of the very influential persons and made great contributions through his career to play dual roles as scientist and also a public speaker for science.

Science is becoming a business more and more, and is being managed in such a way for efficiency and specific targets within certain time limit specified. This is especially true for the products from science, publication or prototypes. The transformation of scientific results to products and make a profit is out of the scope of this discussion due to the pure business nature. Large and super-large projects of national and international levels and importance are conducted effectively in such a way, such as the Manhattan Project and the Human Genome Project, but relatively smaller ones at individual level do not benefit from the same or similar management practice, especially in terms of deliverable deadline, assessment and monitoring. Because evaluation of funded grants becomes a normal practice for the individuals involved, personal career success and income are also dependent upon one's research performance and the outputs as publications to secure and extend the career contract and future development. Such connections of the multiple factors with increasing emphasis on output importance in different countries have a clear negative impact on the science and its further development in the long term. Actually, the micro-management and assessment will not increase the efficiency of funding use and output performance for the majority and in the long-term, research projects and their objectives are pieced meal down to smaller ones without large or long-term goals to striving for. This characteristic and manipulation of research

culture have down-graded the way in which science had been conducted with greater freedom in the beginning to now under the rules and regulations where drawbacks are apparent to the investigators. This new development has put science into a clearly uncomfortable situation where misconduct and manipulation of data are prone to occur with higher frequencies than before. Though individuals who have been caught are being punished accordingly, such practice has not been eliminated significantly due to the lack of innovation on measures of evaluation and assessment in management of research projects. The future of science is on a definitely unpredictable course with these negative issues around it. This is one of my major worries to express and be recorded here.

A new trend is also clear with a rapid increase of research activities and a high demand for publication of research data from especially developing countries. As more and more countries are putting greater emphasis on education and research because politicians and societies realize the importance of it to the nation, development and economy, including political stability and future prospect (Bush, 1945). This new trend and phenomenon have several serious implications to science, society and also the publishing industries. I would like to express my views and concerns here in the followings. First, more and more people are employed in education and research establishments, and also industrial research centers and laboratories to carry out research projects or experiments, their long-term career future and development including security depend on their research output in many different ways (Weber, 1989). But, the truth of the matter is that the great population of people involved in science as their profession does not translate to more breakthroughs that would be made with a positive correlation between the number of people involved and the discoveries made (Gu, 2016; Chu and Evans, 2021; Radicchi et al., 2008). The negative side of the current situation has been discussed recently elsewhere for selective discipline and subject matter (Gu, 2016, 2020a, 2020b, 2021). Secondly, what is clear now is that with more and more people striving to publish their data as publications regardless of novelty, number of them is one way to increase the performance indicator and it weighs more than research originality for career security and promotion. ‘Salami slicing’ is a practice used by some to publish smaller papers quickly to accumulate higher number of them purposefully because the number counts more and sometimes financially than a single comprehensive paper for a good synthesis, information and impact. Similarly, publications in some areas without significant novelty are produced repetitively with changes of a few insignificant variables involved to science without fundamental or conceptual framework being analyzed or challenged to advance the fundamentals in science (Gao and Gu, 2021; Gu, 2020a). This trend of increasing the number of publications serves a negative role by diluting the fundamental science as high-quality findings because far too many of such low or no quality papers prevent individuals, especially

the young and those who do not have adequate knowledge on the subject to judge selectively of the very fewer good ones (Chu and Evans, 2021; Gu, 2016, 2021; Radicchi et al., 2008). Thirdly, this increase of publishing demand coupling with the emerging commercial publishing with the Open Access model accelerates the situation of massive publication of far too many papers because publishing is becoming more and more driven by the business management and financial success, not by academic and intellectual standards as the most important and key criteria. It is also apparent now that highly esteemed society journals are not being favored by the speed of processing, reviewing, and publishing or bibliometric data, which are being used in evaluation of impact of published papers or the individuals. Google Scholar is one example for this and publishing companies are also making their own rules to promote publication as the goals not the academic quality. This phenomenon will result in a shift of the academic credibility being dominated by business success and customers friendliness approach than strict academic criteria of high standard. This is far more dangerous to the future of applied sciences and their development than the pure and physical sciences.

Future prospects

I am not a pessimist in any way to express my negativities against the positive ones here, but my intention of this commentary is clearly to warn politicians and administrators on one hand, and researchers and scientists on the other at the same time to realize or acknowledge the potential pitfall to science due to the current rules and policies implemented. Open Access as a way to disseminate information quickly and widely shall be appraised for, but the core of this new format must be based on quality findings, not profit driven as its goal. It is better to critically analyze the new emerging trend in management of science and research projects, and also simultaneously to conduct a critical analysis of the new publishing model and the financial incentives to the publishing companies, so that the academic quality can be built into the business framework to serve the successes in science and also business at the same time. Any tilting of the balance between them will be a dangerous one, but it is better to acknowledge the potential issues earlier than later for the benefit of science and also the society as a whole. Indicators for scientists must be comprehensive and meaningful enough by discouraging population of science by massive publishing to select contributions for science and/or society on fundamentals and quality. The future of science is largely dependent upon the on-going policies and the accepted ways of doing it. Some of the ‘soft science’ disciplines, which do not have a clear standards or rules of practice or judging criteria as strict as in pure and physical science, e.g., mathematics, physics, astronomy, genetics, etc, must be more closely monitored and checked for a healthy development. Above all in science, it is not the number of many, but the

truth, which can be a single person and only, to made the movement forward significantly. Copernicus, Newton, and Einstein did it, so Watson and Cricks more recently. It is these individuals we need more in science for the future to come.

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Conflict of Interest

Author declares that there is no conflict of interest in the information presented here.

Ethical approval

This article does not contain any studies with human participants or animals performed by the author involved.

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