Chapter 15
Public Education About Science in Singapore: The Role of Science Journalism via Newspapers

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Abstract This chapter explores the role of science journalism in contributing towards public education about science in Singapore, an aspect which is under-explored in the literature. Though the key platforms for promoting public understanding of science are spearheaded mainly by institutions that promote informal science learning as well as by learned societies, the contribution from newspapers is also important. Content analysis of one continuous week of a national newspaper was undertaken, and the results show that coverage of science and technology was modest and predominantly news driven. For news stories set locally, there was a pronounced emphasis on the use of institutional actors in the text as well as quotations. Articles on health/medicine and earth science elicited the most coverage in the press. Some suggestions for using newspaper science to introduce inquiry in the science classroom are discussed.

Keywords Science centres • Scientific societies • Singapore • Science journalism • Content analysis • Straits Times • Science and technology • Inquiry • Nature of science

Introduction

Developments in science and technology are impacting society to such an extent that it is increasingly important for the public to keep abreast of these developments to some extent. They would then be in a position to make informed decisions on matters related to science and technology that affect them. For example, high cholesterol foods are increasingly being partaken by people in today’s urban societies – are they aware that cholesterol can be deposited on the walls of blood...
vessels and later give rise to heart problems? Furthermore, with the pervasive influence of globalisation, borders between countries have become more porous, and developments in one country can affect another. Air travel has shrunk distances between countries, and infectious diseases can spread quite rapidly from its source, which could be in another distant part of the world; also, forest fires in one country can affect air quality in neighbouring countries. As such, people do need to know what steps can be taken in order to mitigate such risks. More such examples can be given, but the point to note is that people need to have some basic science literacy in order to manage risks as well as to be able to make prudent decisions on matters related to science and technology that affect them. This is where public education about science can play a useful role.

Science and technology are also recognised as instruments for socio-economic development. Many countries in the West have used this approach to provide their people with a good standard of living. Such an approach for development is possible when people are receptive to the potential of science and technology to promote economic development and their well-being. Again, public education about science is essential. A scientifically literate citizenry can help governments to realise socio-economic objectives (Tan & Subramaniam, 1998).

Public Education About Science in Singapore

Various mechanisms exist for the dissemination of science and technology to people in Singapore, a country located in South East Asia. Singapore has made great strides in providing its people with a good standard of living, mainly through science and technology-driven economic development as well as good governance. Science and technology impact on many aspects of societal endeavours in this tiny island state.

The role of schools in imbuing students with basic science literacy is very important in their early years. There are also a number of institutions that promote informal science learning to people, and these efforts give rise to useful tributaries for the cause of public education on science. In this context, the roles of the Science Centre Singapore (Caleon & Subramaniam, 2005, 2007; Dairianathan & Subramaniam, 2011; Tan & Subramaniam, 1998, 2003) and the Singapore National Academy of Science as well as its constituent societies (Tan & Subramaniam, 1999, 2009) are well documented. Destinations such as the zoo, bird park and botanic gardens have also played a useful role in public education about science. However, some aspects of public education about science in Singapore have been under-explored (or not done so systematically) in the literature. One of these is the role of print journalism. In reaching out to the public through the print media, there are two key avenues in Singapore – articles in the best-selling local science magazine, the Singapore Scientist, and science-based articles in the national daily, The Straits Times.
The *Singapore Scientist* is a popular science magazine published by the Science Centre Singapore. It has been in publication since 1977 and has a readership of about 60,000. Its readers comprise mainly students, but copies of the magazines are also sent to the local institutes of higher learning as well as various government departments and statutory boards. The quarterly magazine is available for sale, mainly through subscriptions for students and direct sales through bookshops. Articles in the magazine come in various forms – for example, articles written by science centre staff and local academics on contemporary topics in science, quizzes, competitions (with prizes) and information about upcoming attractions at the science centre. As the magazine is printed in colour and on glossy paper, it is attractive from a design standpoint. Typically, it is of 50 pages in length. The efforts of popular science magazines also play a useful role in helping to enthuse the school-going public about the multifaceted splendours of science and technology. While somewhat different from other established popular science magazines, such as *Popular Science* and *New Scientist*, as the latter two are managed by full-time staff, inclusive of editorial, production and marketing teams, as well as having an international readership, the *Singapore Scientist* magazine relies almost totally on staff from the science centre to contribute most of the articles and take care of the editorial work and artwork. Profit is not the motive for publishing the magazine, popularising science is. Its circulation is also mainly local. Since the writing in the magazine is generally pitched at the level of school students, often difficult topics can be communicated in a way that they can reasonably understand. More importantly, the fact that a popular science magazine has been in production for over 35 years in Singapore without a full-time editorial and management team and with minimal reliance on advertisements is a testimony to its effectiveness in contributing to public science education in Singapore.

*The Straits Times*, a national newspaper which has a history of over 150 years, regularly carries articles related to science and technology as well as those related to socio-scientific issues, besides others. The articles comprise those written by its own journalists as well as those provided by international wire services. The importance given to science can also be seen from the fact that a few reporters cover the local science and technology beat. Given the high circulation of the national newspaper, such articles do reach out to a good number of people in the country and contribute in some way to sensitising them about issues related to science and technology. It is, however, of concern that no study has so far explored the role of newspapers in science journalism in the Singapore context.

As it is beyond the scope of this chapter to explore both newspaper coverage of science and how a popular science magazine reach out to the public, this study focuses only on the former. The latter is worthy of a separate study.
Literature Review on Coverage of Science in Newspapers

Examination of the science communication or science education literature shows that newspapers have been the subject of quite a number of studies. Some have explored science coverage in the press, while others have focused on how newspapers could be used in the classroom for teaching, promoting critical thinking skills and examining controversial issues in science.

Science coverage in the various national presses has been the subject of a number of studies – for example, Pellenchia (1997) and Logan, Peng and Wilson (2000) studied it in the US context; Bucchi and Mazzolini (2003) explored it in the Italian context; Wellington (1991) surveyed it for the case of Britain; Metcalfe and Gascoigne (1995) probed it in the Australian context; and Dimopoulos and Koulaidis (2003) presented it in respect of Greece. The general impression that emerges from these studies is that science is gaining prominence in the press, but its share of the total coverage is still rather low. Topics which cornered the predominant proportion of the column space allocated to science in these papers are related to health and medicine.

Very few newspapers have dedicated science sections, and for those that have, only one has been the subject of study. For example, The New York Times has a Science Times section, and this has been the subject of studies by Fursich and Lester (1996) and Clark and Illman (2006). It was found that a range of science topics was covered in this section and that this section has been growing in importance over the years.

A number of authors have explored the coverage of selected topics in the sciences in newspapers. For example, Morvillo and Brooks (1995) focused on articles in biology in the press to stimulate students’ interest in the subject, while Stamm, Clark and Eblacas (2000) explored how the public understood the issue of global warming.

Some authors have explored the coverage of certain events in the press. For example, Friedman, Gorney and Egolf (1992) studied how the US media covered the Chernobyl nuclear accident. Massey (2000) explored how three newspapers in South East Asia depicted the haze which enveloped the region in 1997–1998; one of the newspapers studied was The Straits Times from Singapore.

The literature review suggests that almost all studies of science coverage in newspapers originate from Western countries. No comprehensive study of science coverage in the press in Asian countries has been located. There is thus a gap in the literature that would be of interest to address.
Methodology

Content Analysis

Studying the coverage of science in newspapers is a challenging task. The sheer diversity of the articles and the content therein necessitate the use of appropriate methodologies in order to uncover answers to research questions. Content analysis is one such technique. Riffe, Lacy and Fico (2005) define content analysis as ‘the systematic and replicable examination of symbols of communication, which have been assigned numeric values according to valid measurement rules and the analysis of relationships involving these values using statistical methods’. It is an effective tool that can be used to analyse written text in books, newspapers and other printed documents (Krippendorff, 1980). The technique is regarded as labour intensive and time consuming since extensive coding schemes have to be developed for the analysis. It is also non-obtrusive in nature since the approach does not entail dealing with human subjects.

In the literature, content analysis has been one of the common approaches that have been used to analyse newspaper coverage of articles. For example, Granner, Sharpe, Burroughs, Fields, and Hallenbeck (2010) have used this technique to evaluate newspaper articles related to physical activity. Some studies that have used content analysis to explore science coverage in newspapers include those by Dimopoulos and Koulaidis (2003); Logan, Peng and Wilson (2000); and Clark and Illman (2006).

The framing of an article in the press is an important consideration in its appeal to readers. The term ‘framing’ refers to the ‘modes of presentation that journalists and other communicators use to present information in a way that resonates with existing underlying schemas among their audience’ (Scheufele & Tewksbury, 2007, p. 12). These authors also noted that the way an issue is depicted in a press article has a bearing on how the public would interpret it and form their opinions. Sometimes issues are complex to understand, and the reporters have to resort to particular perspectives in order to get the message across to readers. By giving a certain slant to an article, it is possible for a particular message to be conveyed to readers. The notion of ‘frame sponsors’ (Deprez & Raeymaeckers, 2010) or the participants selected to partake in the process of building the frame is also closely tied to legitimising the views of an article. It helps if the participants are in positions of authority so that they can lend some credibility to the news report (Wilkins, 1993). Content analysis can be used to study framing in a news article.

Using content analysis, the principal objectives of this exploratory study were to:

1. Explore the scope of coverage of science and technology in The Straits Times
2. Study the domains into which science and technology coverage can be mapped
3. Examine how articles with a local flavour are framed when reported in the press
4. Suggest some implications of newspaper science for science teaching based on this study
Choice of Sample

A major English language daily from Singapore (The Straits Times) was selected as the newspaper of choice for this study. A week of newspapers, running from 20 April 2013 (Sunday) to 26 April 2013 (Saturday), was chosen for analysis. This represents a convenient sample. It was not possible to procure ‘two constructed weeks’ (Hansen, Cottle, Negrine, & Newbold, 1998) of newspapers for a year as not all the articles are stored in online databases and also the university library stores hard copies of the newspapers for only a few months owing to space constraints.

Operationalising of Categories

The literature was consulted for the choice of categories to classify the articles. For classifying an article, its thrust needs to be predominantly in line with a particular category. Some examples for the relevant categories are now given (Table 15.1):

| Categories          | Examples                                    |
|---------------------|---------------------------------------------|
| Health/medicine     | Dengue, cancer, surgery, H7N9, etc.         |
| Earth science       | Clogged drains, forest fires, air quality, recycling, earthquake, environment, etc. |
| ICT/technology      | Copper-based phone line, digital map, iPhone, app, 4G, etc. |
| Chemistry           | Corrosive chemicals, toxic gas, names of chemicals, etc. |
| Biology             | Otter, tulip, etc.                          |
| Energy              | Waste-to-energy plant, LNG terminal, energy security, etc. |
| Astronomy/space     | Planet, satellite, etc.                     |
| General             | Interviews, opinions, general news, etc.    |

Coding of Articles

Each article was read and coded for 15 variables by the author (Table 15.2).

Prominence Index

The term ‘Prominence Index’ has been used in the literature (Caburnay, Kreuter, & Luke, 2003; Granner et al., 2010; Schooler, Sundar, & Flora, 1996) as a numerical measure of the extent of coverage an article has been given in the press. The
Theoretical range of the Prominence Index is 7–18. Articles with a high Prominence Index are more likely to be read than those with a low Prominence Index.

We shall define the Prominence Index ($I$) as follows:

$$I = X_1 + X_2 + X_3 + X_4 + X_5 + X_6$$

where

- $X_1$ = whether article appeared in the front page (3 if yes and 2 if no)
- $X_2$ = whether article appeared in main section (3 if yes and 2 if no)
- $X_3$ = location of article on page (3 if left, above fold; 2 if right, above fold; 1 if left, below fold; and 0 if right, below fold)
- $X_4$ = size of headline in cm (3 if $> 1.91$; 2 if $> 1.27$ and $\leq 1.91$; 1 if $> 0.64$ and $\leq 1.27$; and 0 if $\leq 0.64$)
- $X_5$ = presence of image or graphic (3 if yes and 2 if no)
- $X_6$ = length of column in cm (3 if $> 91.4$; 2 if $> 34.8$ and $\leq 91.4$; and 1 if $\leq 34.8$).

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Table 15.2 Coding scheme used to classify the articles

| Variable            | Description |
|---------------------|-------------|
| Date                | The selected period runs from 20 to 26 April 2013 |
| Day                 | The choice of values runs from Sunday to Saturday |
| Title of article    | This refers to the headline |
| Column space        | This refers to the space occupied by an article and is expressed in cm$^2$ |
| Column length       | This refers to the length of the column and is expressed in cm |
| Type                | This refers to the positioning of an article, and the possible choices are: News article, Letters to the Editor, Editorial, Opinion Piece, Interview |
| Visuals             | This refers to whether there is a picture or graphic accompanying the article. The possible choices are yes/no |
| Headline font size  | This refers to the size of the headline and is measured in cm |
| Location            | This refers to where an article appears in the newspaper; the possible positions are left, above fold; right, above fold; left, below fold; and right, below fold |
| Section             | This refers to whether the article appears in the main section (i.e., in the section attached to the front page or in one of the other sections) |
| Category            | This refers to the subject matter covered in the article and is one of the following: health/medicine, earth sciences, ICT/technology, chemistry, biology, energy, astronomy/space science and general (interviews, policy, opinion, etc.) |
| Institutional actor(s) | This refers to the institution or industry which is mentioned in the article and is restricted to local articles |
| Byline              | This refers to whether the article is written by a staff reporter or obtained from wire services |
| Quote               | This is restricted to articles generated in the local context, and the responses are yes/no |
| Science term        | This refers to the first occurrence of word(s) of a scientific nature in the article |
Inter-rater Agreement

As the number of items in each category was relatively few (2–16), only % agreement was used to quantify the level of agreement between the two raters for the classification of the articles. A 75 % agreement is generally regarded as being acceptable (Skinner, Rhymer, & McDaniel, 2000).

Results

The spread of science articles in the week of 20–26 April 2013 is shown in Table 15.3.

It is clear that articles on science appear on a daily basis throughout the week. A higher percentage (60 %) of the articles appears over the weekend, with more appearing on Saturday than on Sunday. The number of articles appearing on weekdays runs into the single digits, and, taken together, it is still less than the numbers appearing on the weekend.

Table 15.4 shows the distribution of articles according to the eight categories. Clearly, the articles explore content in multiple areas of science and technology but the coverage is not uniform.

In terms of numbers, articles on health/medicine predominate, followed by those on earth science and then ICT/technology. Articles related to the natural sciences have rather low representations – five articles related to chemistry followed by four on biology. Surprisingly, there were no articles related to physics.

In relation to inter-rater agreement, except for the categories of health/medicine, earth science and ICT/Technology, a value of 100 % was achieved for the remaining categories. For the former three categories, the % agreement was respectively 81.3 %, 77.7 % and 87.5 %. Overall, the levels of agreement are considered acceptable. It needs to be noted that a factor contributing to the maximum % agreement in some categories was the relatively small number of items in these categories. The distribution of articles, when measured by space allocation, is shown in Table 15.5.

### Table 15.3 Distribution of science articles during 20–26 April 2013 (Saturday to Sunday)

| Day      | Number of articles | Percentage (%) |
|----------|--------------------|----------------|
| Saturday | 17                 | 34.0           |
| Sunday   | 14                 | 26.0           |
| Monday   | 5                  | 10.0           |
| Tuesday  | 3                  | 6.0            |
| Wednesday| 4                  | 8.0            |
| Thursday | 3                  | 6.0            |
| Friday   | 5                  | 10.0           |
| Total    | 51                 | 100.0          |
A surprising trend was observed when the articles were analysed on the basis of space allocation. There were two articles related to the general category and one on the earth science category which garnered the most column space (>1,000 cm\(^2\)) in the week surveyed. In the general category, both articles were opinion pieces written by experts. The article on ‘Riding the Internet wave’ on 20 April was by a university academic who explored the sensitivities of online and offline discourse and what can be done to promote responsible behaviour and accountability on the Internet. The other article on ‘Ensuring healthy outcomes for all’ on 22 April was by a doctor in the private sector who explored the increasing cost of health care in Singapore and how existing insurance and other policy schemes can be tweaked to promote better outcomes for the population. The article published on 21 April is related to ‘Powerful quake rocks Sichuan again’, an event attributed to a quirk of nature and which garnered the highest column space among the three articles. Articles on earth science were represented in all divisions of the column space. It seems that articles related to the natural sciences are given less column space, with

| Category                                      | Number of articles | Percentage (%) |
|-----------------------------------------------|--------------------|----------------|
| Health/medicine                              | 16                 | 31.4           |
| Earth science                                 | 9                  | 17.6           |
| ICT/technology                                | 8                  | 15.7           |
| Chemistry                                     | 5                  | 8.2            |
| General (interviews, policy, opinion)         | 5                  | 8.2            |
| Biology                                       | 4                  | 7.8            |
| Energy                                        | 4                  | 7.8            |
| Astronomy/space science                       | 2                  | 3.9            |
| Total                                         | 51                 | 100.6          |

Note: Percentages do not add up to 100 because of rounding off

| Column space (cm\(^2\)) | Number of articles | Category                                                                 |
|--------------------------|--------------------|---------------------------------------------------------------------------|
| >1000                    | 3                  | General (2), earth science (1)                                            |
| 800–999                  | 2                  | General (1), earth science (1)                                            |
| 600–799                  | 6                  | Earth science (2), health/medicine (2), biology (1), ICT/technology (1)  |
| 400–599                  | 14                 | Health/medicine (5), energy (1), astronomy/space science (1), chemistry (2), biology (1), earth science (2), general (1) |
| 100–399                  | 18                 | Health/medicine (5), energy (1), astronomy/space science (1), chemistry (3), biology (1), earth science (2), general (1), ICT/technology (5) |
| <100                     | 7                  | Health/medicine (2), biology (2), earth science (2), ICT/technology (1)  |
Table 15.6 Prominence indices of science articles covered in The Straits Times

| Prominence index | Number of articles | Category |
|------------------|--------------------|----------|
| 16               | 6                  | Earth science (4), health/medicine (2) |
| 15               | 6                  | ICT/technology (2), chemistry (2), general (2) |
| 14               | 9                  | Health/medicine (3), astronomy/space science (2), earth science (1), general (2), energy (1) |
| 13               | 6                  | Health/medicine (2), earth science (2), ICT/technology (1); biology (1) |
| 12               | 6                  | Health/medicine (2), earth science (1), ICT/technology (1), biology (1), chemistry (1) |
| 11               | 5                  | Health/medicine (2), ICT/technology (1), energy (1), chemistry (1) |
| 10               | 4                  | Chemistry (2), health/medicine (1), ICT/technology (1) |
| 9                | 2                  | Earth science (1), general (1) |
| 8                | 7                  | Health/medicine (2), ICT/technology (2), biology (2), earth science (1) |

Note: In using the value of column length to calculate Prominence Index, an average column width of about 5.5 cm applies for most of the above articles in The Straits Times. In a few articles, the column width is slightly greater than this norm, and for such articles, the appropriate normalisation factor was applied to ensure consistency in calculating the column lengths. The size of the headline font size refers to the first letter in the headline.

physics not featuring at all in the period surveyed. The Prominent Indices of the articles surveyed are depicted in Table 15.6.

There were no articles which attained the highest (18), second highest (17) or lowest (7) Prominence Index. A Prominence Index of 16, which was the maximum noted in this study, was achieved by six articles: four in the earth science category and two in the health/medicine category. A Prominence Index of 7, which was the minimum noted in this study, was achieved by seven articles: two in health/medicine, two in ICT/technology, two in biology and one in earth science categories. The distribution of scientific terms and their frequencies in the newspaper articles are presented in Table 15.7.

The nature of the science terms appearing in the articles can provide some indication of the extent to which an article can connect with the public. The scientific terms were coded into nine categories. As expected, a greater proportion of the terms belonged to the health/medicine category followed by the earth science category and ICT/technology category. Among the natural sciences, biology elicited more terms than chemistry, while physics terms were the least in number. Within each category, a few terms occurred with more regularity in the articles surveyed. For example, there were four mentions of each of the terms dengue, virus and bird flu under the health/medicine category. Under the earth science category, recycling had two mentions. Among the natural sciences, the subject of biology had four mentions of the term ‘mosquito’. Overall, the articles in the health/medicine category contained quite a number of terms which the public may have some difficulty understanding or appreciating – for example, Chikungunya, cardiopulmonary resuscitation, epidemiological studies, psychotherapy, cognitive
| Category          | Scientific term                                                                                                                                 |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Health/medicine  | Dengue (4), virus (4), bird flu (4), H7N9 virus (3), Aedes mosquito (3), coughing (3), vaccine (2), diabetes (2), Aedes albopictus (2), fever (2), flu (2), Aedes aegypti (2), respiratory failure (2), infection, disease-bearing vectors, Chikungunya, first aid, cardiopulmonary resuscitation, cardiac arrests, defibrillator, infectious diseases, human airways, epidemiological studies, resistance to drugs, strain, mental health, psychotherapy, cognitive behavioural therapy, transcranial magnetic stimulation dementia, Alzheimer’s disease, hallucination, Parkinson’s disease, neurodegenerative disease, stiffness of muscles, poor balance, second-degree burns, nerve damage, hand hygiene, drug screening, health-monitoring apps, debilitating diseases, cancer, nicotine, anti-viral drugs, pandemic, immunity, strain, coronavirus, mammal host, drugs, respiratory infection, pathogens, surgery, quarantine, epidemic, heart surgery, cardiac, kidney and brain procedures, heart valves, smoking, obesity, hypertension, kidney failure, breast cancer, respiratory and heart problems, genomic analysis, genes, sequencing of genome, stuffy noses, sinuses, prenatal exposure, autism, rashes, skin irritation, headache, sneezing, runny nose, sweating, fatigue, pneumonia, H5N1, hypertension, hepatitis B carrier |
| Earth science    | Recycling (2), biomass, power, steam, landfill, fossil fuel, municipal and commercial waste, wind power, carbon emissions, pollution, forest fires, air quality, haze, Pollution Standards Index (PSI) reading, waste of resources, air quality, smog, 2.5 μm particles, 10 μm particles, epicentre, 7.8 magnitude, landslides, tectonic plates, tsunami, climate change, global warming, drought, flooding, cyclones, polluted water, super storms, 2.1 magnitude earthquake, water management, sewage, drought, 7.0 earthquake, landslide, pollutants, coal-fired plant, automobile emission, air pollution, green issues, solar cookers, air-filtration systems |
| ICT/technology   | Internet (2), copper-based phone lines (2), iPhone, app, parallel processing, computer, fibre-optic technologies, next-generation nationwide broadband network, modem, fax machines, wall phone socket, digital maps, cartography, telecommunication networks, Goggle, electric car, man–machine interface, 4G, mobile data, smartphones, streaming videos, wireless sensor |
| Chemistry        | Ammonium nitrate (2), fertiliser (2), toxic gas, transparent liquid, metal, corrosive chemical, hazardous chemicals, volatile chemicals, steel, mercury, hydroquinone, salicylic acid, tretinoin |
| Biology          | Mosquito (4), ants, pandas, fish, vertebrates, spine, torso, fossils, evolution, traits, Australopithecus sediba, otters, tulips, growing vegetables, eggs (of mosquitos), cells, mosquito larvae, breeding |
| Energy           | Waste-to-energy plant, clean energy, energy security |
| Astronomy/space  | Solar storms, satellite, radiation, space debris, cosmos, light years, constellation, orbit, faster than light, galaxy |
| Physics          | Electricity (2), lightning current, momentum, electricity, LEDs, charge, batteries, recharging, power |
| Others           | Human computer, mental calculator |

Note: Numbers in parenthesis indicate frequencies; where there is no number indicated, it means singular occurrence of the term.
behavioural therapy, transcranial magnetic stimulation, Parkinson’s disease, neurodegenerative disease, debilitating diseases, coronavirus, pathogens and sequencing of genome. Most of the terms occurring in the ICT/technology category should not present difficulty to the ICT-savvy younger generation in Singapore except perhaps for man–machine interface and cartography; for the latter, a definition, however, was included in the article. As for the terms in the natural sciences, most are within the appreciation of those who have gone through the school science system. Terms with origins in physics appeared in articles in other categories; as mentioned earlier, there were no articles related to physics for the period surveyed.

In relation to the source of the articles, 22 out of the 51 articles were from wire services. This represents 43.1% of the articles published in *The Straits Times* for the week surveyed. The remaining articles were generated by staff reporters based locally and overseas as well as from the public and other invited experts.

Of the 19 articles that have a local flavour and were generated by staff reporters, all made mention of some academic institution(s) or industry in the write-up. Often, there is a quote from the relevant sources.

Of the 51 articles surveyed, 37 took a news angle in the reporting; five were on advances in science and technology, five were letters to the editor, two were invited pieces, one was an editorial, and one was an interview with a scientist.

**Discussion**

Promotion of public education about science in today’s society is a complex undertaking. No one organisation or platform can undertake this task in totality and neither can any one approach cater to this effectively. A multiplicity of approaches is essential. Institutions for informal science learning, such as science centres, science museums, zoos, bird parks, botanic gardens and other destinations, however, continue to be the mainstay of such dissemination efforts as these are dedicated for specific purposes within the ambit of public science education efforts and are also part of their mission objectives. Increasingly, owing to the growing importance of science and technology in this age of globalisation and the pace at which new developments in science and technology are occurring, other approaches which are able to reach out to the masses are also needed to complement such efforts. Print journalism in the form of newspapers is one such medium.

Even with the proliferation of online news platforms, print versions of newspapers still have a role to play in informing the public about issues related to science and technology. As newspapers are published practically every day, people are likely to use this as the principal source to apprise themselves of contemporary matters related to science and technology that can affect them – for example, an outbreak of dengue, bird flu or mad cow disease in the country or occurrence of high levels of haze in a potential holiday destination. The prominence as well as frequency and extent of coverage that newspapers give to such matters can also
help to shape public perceptions of these issues as well as set the agenda for action where necessary.

Content analysis of the articles appearing in one week indicates that there is reasonable coverage of science. Articles on science appear every day in *The Straits Times*, more so over the weekend, thus indicating a pronounced commitment on the part of the editors to feature science-related content. A total of 51 articles related to science were identified for that week. These articles cover a spectrum of topics in health/medicine, earth science, ICT/technology, energy, biology and chemistry as well as those of a general nature. Their role in contributing towards the cause of raising public awareness of science and technology cannot be underestimated. The proportion of science coverage as a function of the total number of pages in the newspaper is estimated to be less than 1%.

As expected, articles related to health/medicine dominate in the press. In the period surveyed, about 31.4% of the articles published in the press can be linked to this category. People do care for their health and often rely on the press to keep them informed of epidemics and other relevant issues of importance. The dominance chalked up by this category is also reflected in a number of other studies which explored science coverage in newspapers – for example, Bucchi and Mazzolini (2003) and Pellenchia (1997).

A notable finding from this study is the lack of substantive coverage of the natural sciences in the press. While the subjects of biology and chemistry were able to elicit at least a few articles in the period surveyed, there was none whatsoever for physics. A few reasons can account for this. Firstly, it could be due to the limited time period surveyed. Secondly, there has been a marked decline in interest in physics among students at the secondary and postsecondary levels (Oon & Subramaniam, 2010), leading to a decline in undergraduate enrolment in physics at the local universities (Oon & Subramaniam, 2011). The lack of reporting of issues related to physics could well be a manifestation of this trend, that is, it is being perceived as being minimally newsworthy. Thirdly, and which is the most plausible reason in my opinion, is that physics has become very much embedded in many other disciplines, including technology, that its purveying per se is not really necessary to reinforce its importance. There is no technology in the medical, biological, chemical, computing and engineering fields that does not make use of some fundamental concepts grounded in physics. That is, there is an implicit, though not explicitly stated, manifestation of the influence of physics in the sciences. Notwithstanding the foregoing, there is a need for more advocacy efforts by university staff in physics as well as members of learned societies in physics to raise the profile of physics in the newspapers.

Judicious use of the editorial page to reinforce an important point of view is of significance. In the editorial on ‘Joining hands on Earth Day’, published on 22 April, a compelling stand was made for promoting greater individual action towards the cause of the environment. Using the auspices of this page to relay an important message is not only responsible journalism but is also of significance as, besides the front page, the editorial column is also considered to be prime space that attracts attention. The pronounced importance of this column in contributing
towards the cause of agenda-setting has been noted in the media literature (Wallack, Woodruff, Dorfman, & Diaz, 1999).

Two articles that garnered the most column space were in the general category. In both these articles, advocacy for particular points of view was evident. For quite some time, there has been some tension on where the new ‘normal’ in online discourse, which permits anonymity and little accountability, should be positioned. The provision of a large column space in a national newspaper for a leading legal academic to air his views about the Internet has the effect of raising the visibility of the issue for the various stakeholders. Likewise in the other article on how healthy outcomes can be promoted for people in this age of increasing health costs, the views of a health professional in the private sector were given valuable column space to generate publicity for the issue. Distanced from the public health sector, his views provide a perspective from the private sector in the ongoing health-care debate. Such advocacy efforts by stakeholders through the media are well recognised in the literature for furthering the cause of an issue through its pivoting on not only the public agenda but also the agenda of policy makers as well (Davidson & Wallack, 2004; Dearing & Everest, 1996).

Citizen-generated science content in a newspaper is a welcome development. It promotes valuable insights from the ground on issues that may not have been covered in depth in the newspapers or which profess to offer refreshing perspectives. During the period surveyed, there were five persons who penned letters to the editor on science-related issues, mainly on health and ICT issues. Though the column space devoted to these particular letters is either low or modest, the auspices of the forum page can have the effect of elevating it to a higher level of ‘visibility’ for the views professed in these letters. For example, the writer of the letter on ‘Clogged drains: a dengue risk’ demonstrates commendable civic activism as he recounted how he took photographs of stagnant water in parks and drains, which are potential sites for mosquito breeding, and sent these to the relevant national agency for the necessary action, which they duly took. As Singapore was encountering a dengue epidemic at that time, such actions show how other members of the public can contribute in similar ways to the cause of public health. It is well known that letters to the editor must pass through a few layers of scrutiny before they are accepted for publication in the newspaper. Nevertheless, even within the aegis of this ‘mediated arena’ (Zamith, Pinto, & Villar, 2013), it is a welcome development that the public raises issues related to science and technology and that the editors see value in publishing such perspectives for furthering the cause of public discourse.

There is a liberal occurrence of science terms in the press for the period surveyed. Most of the terms with origins in chemistry and physics as well as some in biology should not present difficulties for upper secondary and postsecondary students – for example, terms such as corrosive chemical, hazardous chemicals, volatile chemicals, fertiliser, toxic gas and ammonium nitrate are well within the scope of the school curriculum in chemistry. Likewise for terms such as vertebrates, spine, torso, fossils, traits and larva in biology, as well as terms such as current, momentum, electricity, LEDs, charge, batteries and power in physics.
However, students are likely to find difficulties with more terms in biology than in chemistry or physics (Table 15.7). It is pertinent to note that one of the prime attributes of science literacy is the ability to understand scientific terms (Miller, 1983; Thomas & Durant, 1987). The baseline knowledge in science that schools provide students is adequate, and the onus is really more on students to increase their repertoire of scientific vocabulary and understanding of science topics through informal means in order to make greater sense of the science content presented in newspapers.

It is fortuitous that less than half of the number of articles related to science is from wire services. A good number of the articles were generated by staff reporters, with only a few by letter writers and invited experts. Cooper (2008) has noted that the bylines of articles can provide useful information about the source of the news and that a greater number of articles generated by staff reporters as compared to those from wire services indicate a higher level of professionalism in the newspapers. It ought to be recognised that all newspapers rely on a mixture of staff-generated content and those from wire services. The analysis of the data presented in this study indicates that science is getting the desired attention in the local newspapers.

With regard to the framing of the articles generated locally, an overwhelming majority took a news angle for the reporting. With the mountains of garbage in most countries being either directly incinerated or dumped into landfills, the article on 20 April that a Singapore company is building a waste-to-energy plant in Britain is a reinforcement of the point that Singapore is one of the very few countries that have adopted environmentally friendly practices in waste disposal and that the experience in this initiative has led the company to land a contract to replicate the Singapore experience in the UK. Waste-to-energy plants are a new development in the waste industry – their principal advantage is that the enormous amounts of heat generated during incineration is captured and fed to the country’s electricity grid rather than being allowed to go to waste, as is the practice in many countries (Tan & Subramaniam, 2012). The 20 April article on ‘Indonesia fires bring haze to Singapore’ is a timely reminder to Singaporeans of the environmental consequences that the action of one country can have on another and of the need to stay tuned to the three-hourly broadcasts of the Pollution Standards Index (PSI) readings. Even most of the articles from overseas also took on a news angle for their reporting. The article on ‘Taiwan confirms first case of H7N9 outside mainland China’, published on 25 April, is a poignant reminder (without explicitly stating it) to citizens to exercise caution and discretion when travelling to affected countries and reinforces the point that in this age of international travel, people and local health authorities need to stay vigilant. In the article on ‘A can of soft drink a day ups diabetes risk by 22 %: Study’, published on 25 April, a subliminal message is reinforced to people to take greater responsibility for their own health. Such education of the public about issues in science and technology would seem to be more effective if the message is relayed as a news story rather than as a direct exhortation couched in purely scientific terms with scarce regard for context. It may be pertinent to recall the work of Hijmans, Pleijter and Wester (2003), who have
noted that the use of news items allows for relevant scientific knowledge to be slanted into a story for public consumption. This holds true for the articles in *The Straits Times* for the period surveyed.

In relation to other aspects of framing, it is of interest to explore the nature of the institutional actors that characterise science articles generated locally. As mentioned earlier, of the 19 such articles, all made mention of some academic institution(s) or industry in the text. The positioning of an article in this manner may admit of a reportorial acknowledgement that greater authenticity could be endowed on the content if institutional actors are given some, albeit brief, column space. Thus, for example, in the article on ‘Residents more worried about dengue’, which appeared on 20 April, the Healthway Medical Group and the National Environment Agency earned mentions. It may not be prudent to feature such an article depicting people’s concerns if major players in the big picture are left out and their views not sought. In another article on ‘Boy burnt by liquid on seat of bus stop’, which appeared on the same day, the name of the boy’s school as well as the National University Hospital was mentioned. In the article on ‘More sightings of wild otters in Singapore’, which appeared on 22 April, there were mentions of the National University of Singapore, International Union for Conservation of Nature, the National Parks Board and the name of a wildlife consultant. The article on ‘Mad about tulips’, published on 24 April and which publicised the planting of the largest number of these flowers (20,000) in the country, had mentions of Temasek Junior College, KLM Royal Dutch Airlines and the Netherlands Charity Association. In the article on ‘LNG terminal will boost energy security’, there was mention of a minister’s name, the name of the international conference he graced and KPMG Global Energy Institute for Asia Pacific. Most of such articles have also a quote from an authoritative figure or the concerned actor. Quotations can be a proxy for depth of coverage of an issue – if the issue reported on is perceived to be important, the journalist is likely to solicit opinions from credible sources (Davidson & Wallack, 2004). It would seem that adherence to such ‘norms’ – that is, mention of institution and use of quotations – is generally a characteristic feature of science articles generated in the local context. It may be of interest to note that Dimopoulos and Koulaidis (2003) have found that the linkages of science and technology to the corresponding ‘social actors’ are a characteristic feature of science portrayal in the Greek press. In their study, however, the principal actors were mainly those related to the economy and politics, while in the present study, these were mainly national institutions. The difference could be due to a number of reasons – for example, journalistic inclination to include such actors in order to endow greater credibility for their write-up or greater integration of the institutional ‘spheres of influence’ (Dimopoulos & Koulaidis) into the wider science and technology landscape in Singapore as compared to Greece.

Coverage in newspapers is also dictated by the linkages of potential items to recent events, contemporary trends and socio-scientific implications (Miller, 1999; Nelkin, 1995). For example, in the period under study, Singapore was facing a dengue outbreak, and this was reflected by the presence of articles related to dengue on three different days, including one letter to the editor. Internationally, there was
an outbreak of H7N9 flu, and this elicited three articles. The earthquake in Sichuan was the subject of two articles on different days.

There may be an unintended tendency to equate high column space (inclusive of photographs) of articles with greater visibility for the issues surveyed therein. For example, of the articles that generated the most column space, two were in the general category and one was in the earth sciences category. When the visibility of the articles was analysed on the basis of Prominence Index, four were in the earth sciences category and two were in the health/medicine category. Surprisingly, the two articles that generated the most column space in this study did not generate the two highest Prominence Indices. In the literature, the column space area seems to be the de facto measure for endowing articles with visibility. The use of Prominence Index, which is of relatively recent origins, has been the subject of only very few studies. The results of the current study attest to the fact that more research is needed to explore the impact of an article through the use of Prominence Index. Use of multiple measures can help to address the weaknesses inherent in any one measure and help to portray a more realistic picture of the perceived impact of an article in the press.

Science journalism via newspapers has probably a greater reach as compared to institutions such as by science centres, mainly as a result of the print medium being able to reach out daily to their large readership base, which runs into the hundreds of thousands for newspapers. Especially, newspapers are ideally positioned to communicate new developments in science and technology on a timescale that is not possible by science centres – for example, it requires time, resources and funding for science centres to mount exhibitions and other programmes on these developments, and some of these developments many not even be amenable to treatment via exibitry, the principal tool used by science centres to communicate to the public. Since newspapers are published every day, they are in a position to educate the public about new developments in a time-effective manner. However, it has to be noted that given the breadth and scope of scientific disciplines as well as the rate at which new developments in science and technology are occurring, newspapers can cover only a minuscule fraction of what is happening. The fraction that is covered must pass several tests before it can muster editorial acceptance. For example, is the item newsworthy? Is it likely to appeal to a good number of readers? Is the level of language used in the item amenable to comprehension by the lay public? Is advertising space, which brings in revenue, affected in the process? and so on. Thus, it is not surprising that only a limited number of topics can be covered in newspapers. The lack of a daily science section in *The Straits Times* is one reason why the scope of coverage of topics is still limited as compared to other newspapers such as *The New York Times* (Clark & Illman, 2006) and USA Today. *The Straits Times*, however, has a section devoted specifically to science and which appears on Sundays; both locally generated articles and those from wire services are featured in this section.
Implications for Teaching

The way science is presented in school and the way it is portrayed in the press admits of a dichotomy that is not easy to bridge. Science in schools follows a curricular framework, while that in the media is more complex and very much issues driven. Because of the latter, students, depending on their educational level, may sometimes lack the necessary scientific vocabulary or critical thinking to make sense of the content presented in some of the articles though they may be able to follow these to some extent. This is a challenge for science teachers to address as after all, one of the aims of science education is to make students become more discerning in their approach when reading news in the media, a skill that would be especially needed as they transition to adulthood. McClune and Jarman (2010) call this ‘critical engagement with science in the media’. The invoking of relevant articles in the press when teaching particular science topics in the class and coming up with appropriate activities that can provide meaningful learning experiences to students would be a possible approach. These activities can leverage on inquiry in the broad sense. It has to be reiterated that in the literature, there is no consensus on what exactly constitutes inquiry (e.g., Barrow, 2006). True inquiry is generally regarded as being promoted when students engage in tasks that mirror the work of scientists – for example, doing investigations in the laboratory. However, given the need to complete the curriculum in time and to allocate time for revision activities, there is a limit to how much time teachers can devote to inquiry activities for students in the true context of the word. The laboratory need not necessarily be the place, although it is highly desirable, to promote inquiry. In fact, Chiappetta (1997) notes that ‘Scientific inquiry goes beyond constructing knowledge through hands-on activities. Much of the inquiry that scientists and engineers engage in involves reading and communicating with other people’ (p. 25).

The classroom can thus be used to promote elements of inquiry to students – for example, use of questioning and crafting of activities that promote thinking without recourse to the laboratory environment. Questioning and thinking are two attributes that are used by scientists in their work, and these can be made the basis for promoting inquiry when using newspaper articles in the teaching of science. Some examples will now be given using the articles covered in *The Straits Times*. In using the article on ‘LNG terminal will boost energy security’, published on 26 April, for the teaching of chemistry, students can be given some tasks to do – for example, writing the chemical equation for the combustion of liquefied natural gas and comparing it with when petroleum products are combusted, and asking them to explain from the products formed why the former reaction is in line with clean energy initiatives; calculating the heat change for these reactions to see which reaction produces more energy; following the carbon trail for these fuels to study the effects of pollution; and doing simple cost-benefit analyses in respect of the fuels. Another article which appeared on the same day is ‘Banned chemicals found in 3 cosmetic products’. In using this article for the teaching of chemistry, students can be asked to look into the properties of mercury, hydroquinone, salicylic acid
and tretinoin from the point of view of its effect on human physiological systems and find out what is the critical concentration beyond which each of these chemicals can pose a risk to human health; by correlating these concentrations with those found in the cosmetic products, they can see why the authorities have banned these products. In line with the recommendations of Jarman and McClune (2007, 2010), further activities can be promoted when using press articles for the teaching of science in class – for example, engaging students in a brief question-and-answer session based on the article, promoting general discussion of the article and asking students questions such as what aspects that would allow them to make greater sense of the text are missing from the article; if given an opportunity, what would they want to ask the reporter who wrote the article; and what topics in the syllabus have allowed them to reasonably understand the article. Also, students could be given opportunities to write up a science topic taught in class (and which is covered in the newspaper) as a press article with catchy headlines and word limit (Jarman & McClune, 2002).

The interdisciplinary nature of contemporary science and technology is a theme that resonates in most articles. In schools, however, science is taught as separate subjects – for example, physics, chemistry and biology. Where combined science is taught at the secondary level, its division into the respective sciences is still made apparent in the syllabus or in the class during teaching – for example, subject combinations include physics/chemistry, chemistry/biology or physics/biology. Students need to realise that the natural world is interdisciplinary in nature and that these artificial divisions are made for pedagogical convenience and administrative reasons. Science-based articles in newspaper offer tremendous potential to reiterate this point. For example, in the article on ‘Indonesia fires bring haze to Singapore’ which appeared on 20 April, a number of subject domains will be apparent – the slight changes in the composition of the atmosphere due to the presence of colloidal particles as well as the reduced visibility arising from these can be linked to chemistry; forest clearing via burning to make a way for development can be linked to earth science; deforestation contributing to reduced transpiration and photosynthesis has implications in biology; and the body parts affected as a result of such pollution can be related to biology or medicine. In the article on ‘Banned chemicals found in 3 cosmetic products’, linkages can be made to not only chemistry but also biology. Such articles can be used to infuse not only real-world contexts of a contemporary nature in the course of teaching traditional science but also reinforce to students the cross-disciplinary nature of modern science.

There is good scope for infusing nature of science (Lederman, 1999) elements when appropriate press articles related to science are used for teaching. Articles such as ‘H7N9 flu outbreak: Ducks may be the source’ and ‘Experts stumped by how H7N9 virus is spread’, both of which appeared on 20 April, indicate that even though scientists have a reasonably good understanding of the H7N9 flu, their understanding is not complete and, in relation to certain aspects of the flu, their knowledge is still in a state of flux. The article on ‘Golden age of citizen cartography’, published on 21 April, is a good example of what Shapin (1992) terms ‘science-in-the-making’ (p. 29) – how groups of people separated by distance were
able to collaborate over the Internet to create new knowledge, specifically producing an accurate digital map of a part of the country, such as a village. Yet another example of science-in-the-making and which reinforces the point that the scientific enterprise is a complex social activity in which multiple institutions as well as the public participate is the article on ‘War on cancer: US institutions race to map patients’ genes’, which was published on 23 April.

While judiciously infusing newspaper science into classroom teaching can spice up lessons, not all science teachers would have the necessary skill sets to do this effectively. Appropriate professional development programmes would be necessary to upskill them for the task. Given the demands of the school science curriculum and the administrative responsibilities of teachers as well as the perceived benefits of the nexus between school science and newspaper science, its use in lessons must not be construed as an add-on but as one which is integrated into classroom teaching. Otherwise, there is a risk that its introduction would be seen more in the context of an appendage that can be conveniently off-loaded for the resumption of normal teaching. A recent study conducted by Poon, Toh and Tan (2010) in a primary science classroom in Singapore used the format of a debate to extend what students learn about the interdependence of species in an ecosystem to an issue of contemporary significance reported in an international news media – the declining bee population; the students were able to obtain useful insights on the issue as a result of linking classroom content with real-world contexts.

It would appear that the science education curriculum may not yet be ready to prepare students formally for critical engagement of the science that appears in newspapers. However, there is a case for doing so, especially in this age of globalisation and new developments in science and technology. Indeed, the seminal report on ‘Beyond 2000: Science education for the future’ by Millar and Osborne (1998) has called for the science curriculum to be reformed so as to address the challenge of helping students to ‘be able to understand and respond critically to media reports of issues with a science component’ (p. 12). These ideas also resonate in the literature on ‘science for citizenship’ (Osborne, 2000) and lifelong learning (e.g., Solomon & Thomas, 1999). Jarman and McClune (2002) also opine that since articles in newspapers are generally pitched at the level of the ‘nonscience audience’, these would be especially useful for classroom teaching. It would be pertinent to conclude this section by quoting Elliott (2006) in his study of trainee teachers in a university in the UK:

If even people such as these do not regularly follow scientific developments and debate in newspapers, what hope is there that less scientifically minded, scientifically educated, or academic peers do? This makes the case for introducing newspaper science in school classes even stronger. If school students can be given opportunities to read media reports of science and helped to understand and critically evaluate them, there is a chance that more will take up this habit into their adult lives. (p. 1260)
Limitations

The choice of just one ‘continuous week’ to explore the science content in the newspapers is a limitation of this study. Experts have recommended that there should be at least two ‘constructed weeks’ (Hansen et al., 1998; Riffe, et al., 2005) in order to study a year’s coverage of articles in the press. As not all the articles published in the newspaper selected for this study are abstracted in online databases and as the university library does not store hard copies of newspapers beyond about 2 months, it was not possible to come up with two constructed weeks of newspapers on a random basis. As the present study was of an exploratory/pilot nature, it was felt that the choice of one continuous week was reasonable, given the constraints. It is also pertinent to add that the use of one continuous week of newspapers as the temporal horizon for analysis has also appeared in the literature (e.g., Wellington, 1991).

The choice of categories used in the classification of the articles is not mutually exclusive, and it is possible that a few articles could be placed in more than one category or that alternative categories beyond those described could emerge. This is a consequence of the interdisciplinary nature of science, which means that more than one category can often be apparent in the articles. The literature suggests that categories emerging from content analysis should have clearly demarcated domains into which content can be placed unequivocally (Chadwick, Bahar, & Albrecht, 1984). It has to be noted, however, that the recommendations by the authors were made in the context of social science research, from where the term ‘content analysis’ was derived, and its applicability to studies on science coverage in the press may have to be treated as a special case where exceptions would have to be made.

Column space (inclusive of photographs, where present), in terms of length and area, was measured with a simple ruler, and thus the accuracy of the values obtained is limited by the precision of the ruler used. However, they are not expected to influence the interpretations offered in this chapter.

It has to be stressed again that this study is of an exploratory nature and that the intent is to get some insights about the science portrayed in newspapers in Singapore as this is lacking in the literature. A more comprehensive research on the role of newspapers in contributing to public education about science in Singapore would be worthy of a funded study. Future work could build on the present study by expanding the time horizon over which science-based articles are surveyed and exploring more nuances in the framing of the articles as well as the salience of these frames. Other topics which could be explored are how controversial issues in science are presented, what the tone of coverage in the articles is and how the tensions between multiple perspectives in a topic are managed in the various articles.
Conclusion

In Singapore, public education about science comes under the mandate of a few agencies dedicated to informing the public on such matters. Contributing to and complementing these efforts are the efforts of other platforms. The role of science journalism via newspapers is such a platform and it has been explored in this study. It is shown that there is modest coverage of science in one major local newspaper, with the coverage being more pronounced for health/medicine and earth sciences for the period explored. As the newspaper medium has not been explored for science coverage in the Singapore context in the literature, this chapter is a small contribution in this respect.

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