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3.3.3. Nine steps toward science literacy for policy: Fostering science, technology, and policy literacy

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Abstract

Administrators and researchers working on cross-disciplinary social issues need a broad range of skills to be able to translate scientific judgment into practical problem-solving. In other words, besides specialized knowledge in a particular field, scientific literacy—that is, the ability to think scientifically about a wide range of things—is the key to solving the problems facing modern society. The need for scientific literacy is likely to grow in future. However, historically speaking, there has not been sufficient education in research methodology in Japan in respect to thinking about issues through a scientific lens and applying them to policymaking or other societal contributions. As such, there is an urgent need to develop human resources with the ability to bridge science and society in promoting "science for policy." This paper presents a framework for what we term "science literacy for policy," that is, the ability to bridge science and society. More specifically, this paper uses the attrition rate in nursing as a case study to illustrate the nine steps involved in this framework.

Keywords

Scientific literacy, human resource development, research methodology

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Main text

In Europe and the United States, science for policy has been actively promoted over the past decade. Representative examples include the dashboard[2] of the NSF in the US, SRP[3] in Australia, and SGMAP[4] in France. Well-known university programs include the University of Michigan's Science, Technology, and Public Policy Program[5] and the Science Policy Internship Program offered by the University of California, San Diego.[6] The Science Policy Research Unit at the University of Sussex the U.K. has made significant achievements in the fields of energy, industrial management and economics, and is also notable for its joint research with Harvard University science and technology for defense policy.[7] In Europe, institutions such as the United Nations University Maastricht Economic and Social Research Institute on Innovation and Technology,[8] as well as the University of Oslo[9] in Norway have actively promoted research on science and technology-based policies and scientific policies to develop technology, leading to a number of publications. In Japan, at least forty-three university research institutions are engaged in science, technology and innovation policy[10] according to the CRDS survey of domestic and international education and research programs (2017).

More than two decades into the twenty-first century, it may no longer acceptable to enact policies without any scientific basis, but the education of scientific literacy in Japanese universities remains old-fashioned. In Europe and the United States, courses on "scientific thinking" are offered in the faculties of major research universities and preparatory high schools.[11] Moreover, the university entrance examinations (Scholastic Aptitude Tests, SATs) taken by North American students focus on assessing their ability to draw conclusions based on evidence and logic, rather than rote memorization. Conversely, in Japan, even major research universities offer few classes on "scientific thinking," "the scientific method," or "scientific literacy." Additionally, the overwhelming majority of research on the subject itself has been conducted with secondary science education in mind, and as far as we can see, no research has been conducted in the context of higher education. This is why SciREX is so important.

Nevertheless, the domain of science literacy is not limited to science in the narrow sense. Scientific literacy does not focus solely on knowledge and understanding of the concepts and methods of science, that is, in the limited sense of natural science that derives principles and laws through methods such as natural observation and experimentation (cf. Omi, 1996). On the contrary, it includes society as a whole as a subject

2 https://labs.data.gov/dashboard/offices
3 http://www.science.gov.au/scienceGov/ScienceAndResearchPriorities/Pages/default.aspx
4 http://www.modernisation.gouv.fr/en/our-activities/evaluating-public-policy
5 http://fordschool.umich.edu/stpp; cf. http://ihpi.umich.edu/csp
6 http://aip.ucsd.edu/programs/ucdc/spip.html
7 http://www.sussex.ac.uk/Units/spru/hsp/Harvard; https://sites.fas.harvard.edu/~hsp/about.html
8 https://www.merit.unu.edu/about-us
9 https://www.sv.uio.no/english/research/phd/structure/TIK.html
10 https://www.jst.go.jp/crds/report/report04/CRDS-FY2017-RR-03.html
11 Jurecki and Wander (2012)

of study, including the formulation of policies based on scientific evidence. In other words, "science for policy" also plays an important role in science literacy. As such, it is essential to pursue scientific research methodologies that can lead to social contributions. In the United States, this research methodology has been deliberately incorporated into educational curricula for children aged three to six years.[12] However, even in the US, which actively teaches "science for policy," not all policies are based on scientific evidence; indeed, there are many politicians and citizens who are anti-science. Nonetheless, it is clear that government officials have a common understanding of "evidence based policies," in contrast to Japan where there is little education in "science for policy."

Given the foregoing, it is worth briefly introducing science literacy, with the understanding that it is not "literacy about science" but "scientific thinking literacy for policy." More specifically, we use a study on nurse turnover (Fumiko Nakajima et al., 2015) as a case study to illustrate the framework, which is roughly divided into nine steps.

1. What is at stake: Detailed definitions and limitations in the literature

Many of the studies attempted by Japanese scholars have been too vague and limited in scope. For instance, the title "Nurses and burnout" does not provide the reader or researcher with a clear idea of their aims or methodology. Rather than "A and B," an actual research question should be more clearly defined, such as "What can improve B in A?" When multiple factors are involved, the process of narrowing them down is crucial. For example, researchers can narrow things down to just one factor while considering multiple solutions or measures or multiple areas and target groups.

2. Once the problem is solved, who does it benefit? Who should pay?

With unlimited wealth and human resources, we can solve all kinds of problems. However, because we have limited wealth and human resources, we must think about how to use them wisely and profitably. We use the term "triage" in emergency medicine: under circumstances where it is impossible to solve all problems at the same time, we prioritize those that offer the highest return on investment, leaving aside those that will be resolved naturally with time, and those that will not be resolved regardless of the efforts or attention they receive. In the case of our research on attrition rates in nursing, the idea of "increasing nursing salaries by more than double" seems plausible at first glance, but without patients and hospitals to pay for it, it would be impossible under the national budget. Although neither patients, hospitals nor the state want nurses to leave their jobs, they cannot afford the cost of retaining them. Put another way, using the example of counselling for the bereaved, it is desirable to soothe the feelings of those who are left behind, but this alone is not enough for the state or hospital to continue paying the counsellor. Rather, if it can be proven that the health of the bereaved has improved, that they have returned to work and paid more taxes, and that the healthcare deficit has been reduced because they are less dependent on medical treatment,

12 https://www.scholastic.com/teachers/articles/teaching-content/scientific-thinking-step-step/

then some of the extra money resulting from this could be spent on funding bereavement counselling. In this sense, without clear proof of its costs and benefits, a "good idea" alone does not make for realistic policies.

3. What is the root cause of a given problem? Is it identifiable? Can it be corrected?

Although it is now good practice to investigate the causes of incidents or accidents, there are many cases where they cannot be identified or deemed unfixable. For instance, knowing what causes an earthquake or tsunami does not mean we can prevent it from happening. Suicide, for example, involves a variety of factors that are difficult to narrow down to a "root cause." In the case of attrition in nursing, even if the influencing factors are known to be night shifts and working over the holidays, or stress resulting from work and too many responsibilities, the solution is not to stop providing nursing care to dementia patients at night or during the holidays, or reducing their tasks and responsibilities. In other words, while investigating the causes of these problems is helpful, it is far from the only way to take immediate action.

4. If the root cause cannot be fixed, what responses are available?

If we cannot fix the causes of a problem, how can we take measures to prevent them from repeating themselves? If earthquakes and tsunamis are unavoidable, constructing nuclear power plants directly above active faults and coastlines, which are vulnerable to earthquakes and tsunamis, can be avoided. Even if we cannot identify a single root cause of suicide, we may be able to reduce suicide rates by restricting means of committing suicide (e.g., handguns and charcoal). In the case of attrition in nursing, even if working conditions cannot be changed, it may be possible to prevent nurses from quitting if there is a way to increase work satisfaction and ensure their mental wellbeing.

5 Precedents/successes from measures based on the foregoing (Qualitative research)

Based on the foregoing, it is worth investigating precedents and past successes to determine whether the causes of the problem can be avoided or prevented by means of thorough prior research. For instance, countries like Scandinavia have successfully reduced electricity consumption by introducing daylight saving time.[13] However, the opposite was reported in areas with higher air-conditioning usage.[14] Others, such as Hong Kong, have reduced the suicide rate by restricting the sale of guns and charcoal. While hospitals have highly variable attrition rates, exploring why some retain staff better than others, even with

13 https://doi.org/10/1016/j.enpol.2011.03.057
14 https://www.wsj.com/articles/SB120406767043794825

the same pay and working conditi ons, may elucidate some important measures. The more precedents we have, the better we can explain ourselves and influence those in authority in the future.

6. What data do we need for policy development?

As science for policy is based on data, any supporting data necessary must be carefully considered in advance. The authenticity and appropriateness of the data are also important. First, before looking for your own data, consider what data previous studies have already collected, whether you can meta-analyze multiple case studies, and so on. Even if you carry out your own research, it is better to borrow criteria for evaluation from highly credible sources in your industry or field rather than create new criteria, particularly insofar as this provides a means of conducting comparison going forward. In the case of nurse burnout, researchers such as Pine, Maslach, and Zarit have already developed their respective criteria, which are used worldwide.[15] Therefore, it is important to understand their respective strengths and weaknesses and choose that which is most appropriate. The logical connection between question and policy should be established before conducting an investigation, so as to avoid belatedly wishing that one had included X or Y.

7. Where can new data be collected, and how can it be interpreted? (Quantitative research)

When carrying out independent research, it is necessary to consider feasible target groups, and the potential response rate of any questionnaires. Sometimes it will be necessary to explain how the data will be used and obtain permission from respondents beforehand, thereby avoiding the possibility of respondents withdrawing their consent after the fact. If you wish to analyze the relationship between two or more factors, the value of your analysis will be completely different depending on whether you can prove the existence of a one-way relationship between them, or whether you can prove the relationship but not the causality. For example, if we wish to link patient awareness with nurse exhaustion, it is difficult to believe that an increase in exhaustion will lead to an increase in awareness in the other party, so the one-way logic of "awareness → nurse exhaustion" is valid. However, deteriorating relationships between colleagues can be both the cause and consequence of exhaustion, so this correlation alone does not tell us what the cause is. Moreover, the representativeness of the target group and its relevance to problem-solving are also important. It is important to keep in mind the logic of this data and how it will be applied, as measuring an unrepresentative group of subjects will not be convincing in policy proposals.

15 See all http://www.acqol.com.au/instruments/instrument.php

8. Quantitative and qualitative research to examine the implementation and evaluation of pilot measures

Following data analysis, it is desirable to plan interventions to counter the problems studied. However, nationwide policies cannot be implemented all at once. Prior to this, it is appropriate to conduct a small pilot initiative so that you can review and evaluate its efficacy. For instance, a study by Nakajima et al. found that nurses' lack of work satisfaction and sense of accomplishment were major causes of burnout. The next step involved an attempt to increase their sense of work satisfaction and accomplishment at regular nurse training sessions at a nearby hospital. In this respect, they introduced training and informal check-ins to raise the nurses' sense of work satisfaction and accomplishment, and conducted a simple questionnaire. Later, when using the same questionnaire as before, we were able to see trends in the reduction or continuation of burnout, as well as in sense of work satisfaction and accomplishment, and were thus able to assess the usefulness of this intervention.

However, training and informal check-ins to enhance a sense of accomplishment were conducted by colleagues familiar with the research on work satisfaction. Even if this intervention were to prove beneficial, this small number of colleagues would not be able to do this at the same scale nationwide. Therefore, the use of training materials to enhance work satisfaction and a sense of accomplishment in these sessions for nurses and the training of facilitators for these sessions remain significant challenges to problem-solving via such methods of intervention.

9. Which policymakers will understand the benefits of this approach, and have the authority to implement them?

In point 3 above, we noted that knowing the root cause does not amount to a solution. Similarly, experimental proof of beneficial measures does not necessarily mean that governments or businesses will adopt them in their policies. It will take more than experiments and statistical proof to get people to adopt them in the real world. In order to persuade people to do something they haven't done before; we must communicate how exactly this will benefit them and get them to believe in it. Of course, the task of persuading governments and companies is outside the scope of academic research. However, the research itself will be meaningless if none of it will ever be realized. This means that you need to consider in advance how your research will appeal to people in authority and the departments responsible.

In the future, if collaboration among industry, academia, and government can be realized little by little, there may be further opportunities to convey the results of scholarly research to the real world (industry and government). However, it is unlikely that the policies demonstrated by scholars will be immediately adopted even if such collaborations increase. In other words, the selling points of any research need to be clearly considered from the earliest stages of attempting science for policy. For example, we need to be able to answer questions like "If we invest X amount of people and money in this policy, how much will this save, and how many more people will be able to work?" based on data, and be prepared to make a clear case to policymakers. Although this may not be sufficient on its own, we will not succeed in science for policy if we do not consider such benefits.

10. Conclusion

As we have seen above, the kind of scientific literacy that should be fostered at university does not simply mean memorizing mathematical formulae or elements from the periodic table. Rather, it is a way of thinking about things scientifically and from the ground up. One needs to be able to define and set a problem, collect and analyze data, and use logic and persuasion to connect it to a solution. As John Dewey suggested,[16] this kind of scientific literacy should not be confined to postgraduate education, but taught to all citizens. Even if this is too lofty an ideal, it is desirable to ensure that science programs for STIPS policy communicate ways of thinking such as that discussed in this paper.

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16 Wickman et al. (2011); cf. https://www.ncbi.nlm.nih.gov/books/NBK396086/

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Related data sources

Sites about policy briefs and literacy

- Johns Hopkins University
  https://www.jhsph.edu/research/centers-and-institutes/womens-and-childrens-health-policy-center/de/policy_brief/ index.html
- University of North Carolina
  http://writingcenter.unc.edu/policy-briefs/
- University of California
  https://policyinstitute.ucdavis.edu/informing-policy/policy-briefs/policy-briefs-101/
- Newcastle University
  http://toolkit.northernbridge.ac.uk/essentialskills/communicatingforpolicyaudiences/writingapolicybrief/

Free Japanese big data sites

- http://www.data.go.jp/
- http://datameti.go.jp/data/ja/dataset
- http://www.e-stat.go.jp/SG1/estat/eStatTopPortalE.do
- http://www.ncd.or.jp/

Free International big data sites

- http://data.un.org/
- http://www.who.int/gho/en/
- https://data.unicef.org/
- https://www.ehdp.com/vitalnet/datasets.htm
- http://data.europa.eu/euodp/en/data/
- http://www.census.gov/data.html
- https://www.healthdata.gov/search/type/dataset
- https://data.gov.uk/

Useful sites for industry, energy, public opinion, and visualization:

- http://www.iea.org/statistics/
- http://energyatlas.iea.org/#!/tellmap/-1118783123
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- https://www.kaggle.com/datasets
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- http://landmatrix.org/en/
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- http://wiki.dbpedia.org/projects/sparklis
- http://www.visualdataweb.org/relfinder.php

Information on related base course subjects and research projects

- “Research methodology exercise for policy” (Kyoto University)
- “Exercises in science and technology communication” (Kyoto University)
- “Special seminar on science, technology and innovation policy” (Kyoto University)