Simplified excerpt of a literature review: The Main Goals of Science Education
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How we teach science to children is, at its most fundamental level, dependent on our understanding of why we teach science to children. However, many teachers don't have a clear idea of why they are teaching science, beyond the vague idea that science is really important. The following is a simplified excerpt from my review of science education research into the main goals of science education. While you read it, think about where the goals you discussed with your groups fit into this picture, and try to both broaden and deepen your understanding of why teaching science is important.

Intro to the Goals of Science Education

Since the explicit inclusion of science in the Anglophone curriculum in the mid-19th century, the most visible goal of science education has always been the *economic* goal: to provide nations with enough qualified scientists and technologists. The economic goal remains the primary aim of many nations, despite current widespread agreement amongst researchers and teachers that *science for all* should be the main purpose of science education. The *science for all* goal can be defined as creating a scientifically literate population. However, what is meant by scientific literacy varies widely. In this review I define scientific literacy as the scientific knowledge and understanding necessary to achieve the five sub-goals, as follows:

- The *civic* goal - To create citizens who are capable of fully participating in a democratic society which is increasingly being asked to make socio-scientific decisions;
- The *utility (practical)* goal – To allow people to make better personal decisions on science related issues;
- The *equity* goal - To encourage equity in and through science (e.g. gender, social and cultural), since access to science is access to power in today's scientifically dependent world;
- The *transforming praxis* goal – To promote forms of cultural, social and/or political change with a connection to science; and
- The *cultural* goal– To promote the appreciation and understanding of science because it is an integral part of our culture.

Science for some vs. science for all

It is difficult to argue that the *economic goal* is not extremely important. However, research has shown that when curriculum is primarily based on the economic goal, it fails to provide the majority of students with sufficient scientific literacy. In fact, curriculum focused on the economic goal is even failing to achieve its main purpose. The decreasing popularity of school science among youth is leading to the threat of an insufficient supply of qualified personnel. The *science for all goals* have been proposed as a solution to this problem and many of their supporters argue that building a curriculum around scientific literacy will benefit the majority and not harm those who wish to pursue science as a career, who would arguably succeed in any science setting. Also, by teaching science that is relevant to everyday life, by encouraging equity in and through science, and by helping students see the cultural significance of science, we might encourage more youth to pursue science as a career option. As an added benefit, future scientists might gain alternative perspectives and a greater understanding of the nature of science and its interactions with society. In this way, the *economic* and *science for all* goals can be seen as symbiotic and not competitive. However, researchers have found that when the curriculum attempts to address both goals equally, it ends up catering to those students preparing for a career in science and underserving the rest. The question then remains, if we focus entirely on the *science for all goals*, will the economic goal be achieved? Although there are examples of science literacy based programs, there remains relatively little research on their effectiveness of achieving both goals.

Aspects and arguments of *science for all*

Among the supporters of the *science for all* goals, there is much disagreement as to which definition of scientific literacy is best, and how each goal is to be interpreted in practice. A recent growing movement that focuses on the civic and utility goals is the socio-scientific issues (SSI) movement. The SSI movement seeks to engage students in decision-making regarding current social issues with moral implications embedded in scientific contexts (e.g. climate change). Such issues challenge students' and teachers' perception of science because they lack definitive solutions, and are subject to multiple perspectives. A counterargument to teaching SSI in science claims that the social and political aspects of such issues are not scientific, therefore science

education has no claim on these issues. This argument stems a narrow definition of science, in which experimental results are valid, regardless of the ethical implications. Supporters of this view do not deny that there are political, social and ethical considerations which limit the practice and use of science, but argue that these are not part of science, they are social issues which have a different perspective. They believe that science is divorced from direct engagement with human concerns in its construal of the world. They argue from a realist stance, claiming that science is universal and value-free. In contrast, many others take a constructivist view of science, which views science as being value laden and inextricably entangled with society. *"... we need to know that every piece of scientific and technological knowledge—from a (DNA, benzene) molecule to an IQ test to a mobile phone—is a product of a particular cultural, historical, economic, and political context..."* (Roth 2007, p.393). These two views may be irreconcilable, but as will be discussed later, this does not mean that the goals they promote are mutually exclusive.

Yet another perspective on the *science for all goals* defines scientific literacy as the knowledge and understanding that will allow the general populace to follow science and scientific debates with interest, and to engage with the issues science and technology poses, both at the personal and societal level. This definition supports the democratic, utility, social and cultural goals. However, instead of taking the SSI or other approaches, these scientists and researchers believe that the science curriculum should be organized around narratives or stories of scientific knowledge. They propose that there is too much content in current science education, and that a focus on the processes and nature of science is as important as content (or more).

Proponents of science as an objective field of study have argued that as a result of its scale, power and success, science has an authority which cannot make room for children's individuality. This is a view that is unpopular with many, but especially with supporters of the equity goal. These supporters argue that traditional education neglects a large portion of the population by presenting science as authoritarian and universal. Some even argue that science is not universally homogenous, and our curricula should embrace other ways of knowing science, such as common sense and traditional ecological knowledge. One very vocal supporter of the equity goal is Angela Calabrese Barton who researches and works with homeless children (e.g., see Barton,

1998). Barton promotes science education as a dynamic and back and forth relationship with the world, and therefore she is also a supporter, along with others, of the transformative praxis goal as well as the equity goal. Like the equity goal, this goal is usually promoted in parallel, not at cross-purposes, with the other scientific literacy goals. Distinct from the other scientific literacy goals, transformative praxis defines scientific literacy as a means for changing the world, rather than merely understanding it. This change can take political or social forms. For example, some promote the use of science education in environmental activism. In this way the transformative praxis goal meshes well with both the equity and the civic/utility goals, but takes them one step further, putting the issues they address into practice.

Conclusion

Some thinkers in science education, argue that making scientific literacy the primary goal will result in reduced science education for most students, because other literacies (e.g. language) are much more personal and immediate. It could, however, be argued the personal relevance and immediacy of science is exactly what each of the other *science for all* goals are working to develop. In 1975 it was estimated that, in the United States, more than half of the legislative bills in Congress were science or technology-based and our dependence on science and technology only continues to increase. The problem, then, is not that other literacies are more personal and immediate; it is that the relevance of science literacy has not been fully recognized. Perhaps, as has been pointed out by researchers, the trouble lies in the term 'literacy', which although widely accepted, brings with it some problematic concepts and comparisons (e.g., science vs language). As for now, there are only two points that all researchers appear to agree on: 1) science is an essential component of education for all students; and 2) before we reform and reshape science education yet again, it is necessary to get clarity on our main goals of science education.

References:

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