Volmert, A., Baran, M., Kendall-Taylor, N. & O'Neil, M. 2013, '"You have to have the basics down really well": Mapping the gaps between expert and public understandings of STEM learning', A FrameWorks Research Report, FrameWorks Institute. Retrieved from: https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_088203.pdf

Summary

This 56-page report examines the similarities (overlaps) and differences (gaps) in the understandings about STEM education between experts and the general public in some American states. The authors map a range of overlaps and gaps, which are discussed in the Analysis section, as well as identifying some key challenges in communicating about STEM education. The authors contend that one of the most interesting findings is the role of Science—both cohorts agree that Science is an 'exploratory subject' focusing on how the world works; however, the general public equates STEM as Science; whereas the experts viewed all STEM subjects as equals.

Analysis

While the sample size for this research exercise was not extensive (15 experts and 20 general public), the research methods were intensive (phone, face-to-face, lasting 1 or two hours).

EXPERTS

The authors organised experts' responses around the following five key questions.

What is STEM?

Experts reported that STEM is a 'set of subjects that share a fundamental orientation' (page 13). In essence this meant a focus on gathering and using evidence to answer questions and generate knowledge. The experts acknowledged a range of problems with this acronym, such as undue emphasis given to Science and Maths at the expense of Engineering and Technology, as well as the lack of consensus as to the scope and meaning of Technology.

Why is STEM learning important?

It was proffered by the experts that STEM develops critical thinking skills, which are highly transferrable and that STEM assists students understand social problems and enhance their civic engagement. The latter finding could be explained in terms of what Matthew Miller and Veronica Boix-Mansilla call a multi-causal explanation of complex problems, which is associated with students taking an interdisciplinary approach to learning. STEM also develops proficiencies required for employment.

What are the best ways to teach STEM?

The experts stated that hands-on learning exposes students to an iterative approach to problem-solving and experimentation, and a student investment and ownership approach enhances the learning process as it meets student interests. It was also suggested that STEM learning would be further strengthened through the involvement of STEM professionals in education programs. Introducing STEM education in the early years of schooling was also strongly recommended.

What are the current challenges to STEM education?

As a generalisation, the experts did not believe that the current approach to STEM education was adequate. Reasons for this include insufficient qualified teachers and an over-reliance on a pedagogy that focuses on recall. Experts also identified disparities in access to STEM programs, based on factors such as geographic location and funding, as a challenge.

What are the advantages of informal STEM learning and what is the relationship between informal and formal learning.

Note: Informal learning takes place in settings such as after-school programs, summer programs and museums.

It is apparent from this report that informal learning has a higher profile in children's learning than in Australia. This could be explained, in part, by the opportunities provided by lengthy American summer programs. Experts suggested that informal learning normally took place in smaller groups and in more a 'low stakes' learning context than schools, which could encourage students to take more risks in their problem-solving.

PUBLIC

The research indicated clearly that while there is some public confusion about the nature of STEM, the place of Science and Maths learning is clear in STEM education (particularly Science), but not engineering and technology.

The authors organised the public's responses around the following five key questions.

What is important for children to learn?

Overwhelmingly the public viewed Maths, Science and English education as most important. Maths is considered an everyday skill; English as the communications tool and Science

helps children understand how the world works. Science education was also considered a way of fostering innovation due to its experimental nature.

What is STEM and why does it matter?

The research revealed that many of the general public interviewed were unfamiliar with the acronym STEM, and that for some it was assumed to have a connection to 'stem cell research'. Most respondees equated STEM with Science. There was also confusion regarding what the 'T' meant in STEM with technology being considered only computers, mobile devices and the internet. There was also some public resistance to the use of technology at school as it was perceived to be 'dangerous' (in the social context) (page 24). Engineering, however, was seen to be appropriate, but only for those students who displayed specific talents or interests in the field.

How do children learn STEM skills and why are there differences in STEM learning between students?

Responses to this question where primarily framed through the lens of STEM equating with Science, hence 'hands-on' learning was the dominant answer to the learning style. In some instances this stretched to Science skills being acquired by the children simply going about daily lives (*passive* learning). Some respondees indicated that a child's race ('culture') explained differences in STEM learning abilities and preferences.

What is informal learning and how is it related to STEM?

There was a general consensus that informal learning was associated with greater freedom, flexibility and opportunities than formal learning. Many respondees likened these features to how Science is learned. Some respondees expressed concern that when students engage in informal learning it is at the expense of their formal learning because they don't get enough downtime.

How can we improve teaching of STEM subjects?

Hands-on learning associated with Science was the most popular suggestion for improving the teaching of STEM subjects—it makes learning more fun, realistic and relatable to children's lives.

KEY OVERLAPS

Following are some key areas of overlap in understanding between the experts and the general public.

- Science is an 'exploratory subject' (page 40)
- STEM is important for workforce development; however, there were some differences in the relative perspectives of each cohort (page 40)
- STEM education benefits from a hands-on/application approach rather than a recall-directed pedagogy.

KEY GAPS

Following are some key areas of differences in understanding between the experts and the general public.

- STEM equates mainly to Science (public) whereas it embraces all subjects (experts)
- The public view STEM basically as discrete subjects, whereas experts value the underpinning foundations of an interdisciplinary approach to learning
- Timing—experts suggest STEM education begins in the early years whereas the public want a delayed introduction, particularly for the 'T' and 'E' components, and they are only for those students who have the interest and ability.
- STEM education for whom? The general public thought only the basics should be taught to all students and then STEM should only be for the gifted. This contrasted with the experts who believed that STEM should be for all students.
- Disparities in STEM learning—experts attributed this to lack of access to resources whereas the general public explained differing achievements through the lens of cultural factors and individual abilities.

Reflection

It is interesting to hear the general public's view of STEM and for educators to consider the impact of such views on the success of STEM programs in their schools. It is quite possible that many STEM education programs in Australia favour Science and Maths learning, with 'T' being treated as ICT as a general capability and 'E' barely having a profile. It is also uncertain as whether you can extrapolate the American public's understandings of STEM to Australia. It is reassuring to know that all the Australian Curriculum learning areas that contribute to STEM focus on gathering and using evidence to solve problems and create knowledge and require an inquiry, hands-on approach to learning.