The Law and Technologists: Implications for the Technology Curriculum

Joan Forret

A general theme of technology education posits that participation in technology studies will result in outcomes and (hopefully) benefits for the wider society. Such an expectation is reflected in the New Zealand Technology Curriculum document where the aim of technology education includes enabling students "to achieve technological literacy through the development of: understanding and awareness of the relationship between technology and society." Although technology studies has developed as a distinct curriculum area in many countries, it is important to recognize that technology is not recognized as such by many of those in decision-making roles within our various societies. While educators have attempted to identify technology as a separate endeavor and knowledge system from science (Layton, 1993), that distinction is not necessarily perceived by those who may be very influential in making decisions that have important legal, economic, and social consequences. Research into the views of legal decision makers concerning science and scientific evidence has revealed a very wide spectrum of understanding and expectations of expert witnesses. Judges not only interpret expert technical opinion evidence differently from those within the expert community, they also interpret that evidence differently from each other. In addition, judges and other lay decision makers have various expectations of the expertise and credibility of expert witnesses, and those expectations need to be met to ensure that appropriate consideration is given to their evidence. Technologists give crucial engineering, biochemical, and environmental opinion testimony that can have implications for the suitability of projects involving vast capital investment and the potential for serious environmental, social, and economic effects. Technologists also give evidence in criminal proceedings, and the credibility of that testimony will often be the difference between a guilty or not guilty verdict. Regardless of the type of legal system or social structure within a community, legal decision making will involve inquiry and an increasing reliance on expert opinion. Thus, it is crucial that in any program of technology education, lay perceptions and misconceptions are anticipated and accommodated so that technologists are taught how to effectively communicate their work and the importance of that communication as an aspect of the integration of technology into society (Jones, 1997).

Research with the New Zealand Environment Court

In New Zealand the environment court hears all appeals from decisions made by local authorities under the provisions of the Resource Management Act 1991 (RMA). This act

provides that all local authorities must have planning documents that cover the management of natural resources. Any activity that is not expressly permitted by such a planning document must be authorized by a resource consent. Thus, the court hears a lot of appeals arising from the proposed contents of local authority planning documents and also from those aggrieved at the grant or refusal to grant a resource consent. The subject of appeals varies greatly and can range from relatively minor land use matters, such as approvals for a residential subdivision, to consideration of applications for marine farming or multimillion dollar mining developments that may involve serious environmental and engineering considerations. A failure by an expert witness to effectively communicate his or her opinion on any of the matters significant to a particular proposal may result in the failure of the project at a vast cost to the applicant or, conversely, the failure to prevent a project at a vast cost to the environment itself and also to the wider community.[1] (See also Ayd & Troeger, 1999.)

For most hearings that involve the presentation of scientific or technical evidence, the court sits as a panel of three members, comprising an environment judge and two environment commissioners. The judge is legally qualified; however, the environment commissioners come from a range of backgrounds. The RMA requires that the court has a mix of knowledge and experience including commercial, local government and community affairs, resource management, environmental science and engineering, surveying and mining, and cultural issues relevant to Maori being the indigenous people of New Zealand.

In order to canvass the views of the court regarding the role of science and scientific witnesses, I interviewed all eight judges and 13 of the 17 commissioners.[2]

Classification of Expert Evidence

Technical Expertise

Interview results show that the court could be divided into three unequal groups concerning their understanding of the nature of science. The largest group described science and scientific evidence to include the traditional physical sciences and technology in a wide range of forms, under a general umbrella of technical expert evidence. This group attributed all types of technical evidence to a general category of scientific evidence, including medicine and all aspects of engineering evidence. Many in this group, which comprised four judges and five commissioners, perceived the uniting concept of science to be the empirical basis of data.

Another theme within this technical expertise group was the notion of a methodological basis for the evidence. For example, when one judge who included engineering and medicine under the umbrella of science was asked about his categorization of sociological evidence, he answered affirmatively because "they are giving opinions based on analyses…conducted in, well what I would hope, would be…using the scientific method."

His understanding of scientific method was further described as "the principle of, and gaining systematic formulation of knowledge and in a way that can be tested, tested by replication, I think."

Another member of this group (a commissioner) described the features of pure science as "incontrovertible proof and by incontrovertible, the only proof that's incontrovertible is proof that can be repeated and repeated and repeated and you come up with the same answer. Reproducibility of result. That's pure science." This interviewee had previously indicated that precise technical evidence could be categorized as scientific; however, she described the social sciences as "garbage" due to their "inexactness."

[1] The approval of an application by the government to build a high dam at Clyde, which resulted in the flooding of a fertile valley in intensive horticultural production in the South Island in the 1980s, is such an example. The proposal was vigorously opposed at the time and has since been identified as contributing a significant cost to the country as the result of continued engineering expenses and debt burdens, and the extra hydro electricity produced is not ever expected to balance those costs.

[2] In order to maintain confidentiality, I have coded all of the interviewees as judge or commissioner only and my research findings refer to all of the judges as "he" and to all of the commissioners as "she."

The third major theme uniting the technical expertise group concerned the nature of witnesses' qualifications. This view is well illustrated by the following comments from a commissioner in response to a question asking what makes evidence scientific: "[A] person with discipline…with academic skills and training, qualifications…of a scientific background. …they have got to have a scientific training, academically, and…practiced in that field." Many of this group preferred to discuss evidence as either expert or not and treated all forms of technical evidence under the same umbrella as science.

Hard Science vs. Applied Science

The second group of six commissioners and two judges had a view that technology and technical evidence was different from what they described as "pure" or "hard" science. Most of this group had a view of "applied" versus "pure" science, although they often saw that categories, particularly within engineering, could be rather blurred depending on the evidence being presented. The following comments from a commissioner most clearly illustrate the approach of this group:

> I suppose you really have to distinguish between science and applied science and medicine would have to be applied science, I would say, except for those at the vanguard of research. The same thing, engineers are applying science that somebody else has discovered for the main part.

All Evidence Is Scientific

The third group, comprising two judges and two commissioners, held the view that any expert evidence, and in fact any admissible evidence, was necessarily scientific. These interviewees answered with reference to expert, rather than scientific, evidence.

The "all evidence is scientific" group can be best illustrated by the following comments from a judge when asked if he perceived a difference between evidence and scientific evidence: "I don't quite. It's all evidence, but I think probably what you're getting at is whether it might be relevant in a certain situation." When the same interviewee was then asked what makes expert evidence scientific, he continued: "It never addressed my mind, it would never occur to me. If what he is telling me is relevant to the case we've got before us. To me it's just evidence."

For this group the essential characteristic of the evidence presented to them, whether from a scientist, a technologist, or anyone else for that matter, was the expert nature of that evidence. This idea of expert evidence is important for technology educators. For the effective implementation of any technological development, the technologist must be able to communicate the essence of that development and persuade the relevant decision maker to invest in or approve of it. In a legal framework, that may mean that technologists will be required to proffer expert opinion evidence so that the decision maker or court can make an informed decision. Whether those outside technology education perceive technology or technologists to have a commonality of purpose or method that is different to science is not at issue. Clearly, there are a range of views and many of those prominent in decision making in our societies will have very different views from each other as well as from technology and science educators. However, within the courtroom framework there are some consistent themes that educators should address to ensure that technology students are appropriately prepared for possible future roles as experts.

Characteristics of a "Good" Expert Witness

Independent Evidence

When asked what were the characteristics of good expert witnesses there were some common themes identified by all interviewees as being essential. The most common, which was mentioned by all interviewees, was the requirement that experts, whether classified by the interviewee as a scientific expert or not, should be independent of the parties, but should proffer their opinion to the court objectively and without appearing to advocate for the instructing party in any way. Many interviewees noted that the duty of the expert is to inform the court using their own expert opinion, and the appearance of bias or advocacy was the most commonly described indicator of a "poor" witness.

The appearance of any advocacy or bias on the part of an expert witness could result in his or her evidence carrying considerably less weight, or being completely ignored.

Some interviewees also noted that while the lack of objectivity would damage an expert's credibility, the ability to concede a point would enhance that credibility. One judge described the characteristics of a good expert as follows: "A person who is prepared to concede a point. That's number one. You can pretty well pick… the expert who is going to dig his heels in and no way is he going to shift and that guy is useless…."

This reference to concession of a point was repeated by several interviewees as an indicator of an objective witness—possibly because to do so is almost antithetical to advocacy. However, and more seriously, if the worth of an expert's testimony is judged by how objective, in a nonpartisan sense, the expert is, then experts should be taught how to communicate their evidence accordingly.

Presentation

Another common theme among descriptions of good expert witnesses was the depth of understanding experts had for a particular situation and their ability to effectively communicate their evidence. In some situations effective communication may mean an interesting oral presentation. One commissioner commented:

> …we do have some expert witnesses who…and it is not about their evidence… but they are boring and their voice is hard to listen to. …the best ones are the ones that have a passion and they really believe in what they are on about and that is what they are presenting…and they are clear.

It was also important for the interviewees that experts were able to give their evidence in nonjargon language so as to "educate and inform the court." In some cases the interviewees preferred experts to use everyday analogies as part of their explanations and to use clear and simple diagrams and charts. This ability to clearly explain their evidence was also seen as an indicator of the expert's own knowledge and understanding.

> Personally, if a technical person or a scientist can't explain anything in terms that the person you are speaking to can understand, then I doubt whether they can understand it themselves, in that, they are just parroting terms that they acquired in their studies. Whereas if they really understand it they can explain, at least to an adequate extent. [Commissioner]

This ability to explain issues in language accessible to the lay members of the court does have its limitations, however. One interviewee commented that an expert should not appear to "talk down" to the members of the court or to give the impression that his or her evidence was necessarily superior to that of other experts. Likewise, the clarity and conciseness of evidence was seen by some members of the court to be relative to the type of expert. Those experts perceived to be scientific might have to give longer and more detailed evidence.

Qualifications

When asked how the court measures the expertise of an expert witness, the most common response related to the expert's qualifications and also his or her list of previous publications. The importance of qualifications to some members of the court is particularly evident in the following comment from a commissioner who was describing the process for deciding between several different experts giving evidence on the same subject matter:

> …we find out their commonality of agreement and where they disagree, highlight that…then you will line up the qualifications of the respective experts and that is what we go with. So if one has got an extra degree from Oxford, or something else from Cambridge, or whatever.

A judge also emphasized the importance of publications for the assessment of the credibility of scientific witnesses: "…a scientist has published papers. …the fact that they've published papers in their curriculum vitae…is an important part of their evidence, because they have to qualify themselves as experts."

Given the scope of evidence perceived to be scientific, this latter requirement may be significant for many technical experts because they may not routinely produce articles for publication as part of their professional practice. Such witnesses would have to establish their expertise in other ways, such as giving details of their duration of professional practice or of experience with similar matters to the proceedings before the court.

Expectations Regarding Methodology

When asked how expert witnesses obtained the substance of their evidence, there was no apparent pattern to the requirements for good practice. Some members strongly insisted that an expert must have personally obtained the substance of his or her evidence from measurement of data. Several commissioners commented that they had been personally admonished in court when in their earlier working lives they had appeared as expert witnesses and had proffered evidence that was not obtained under their direct supervision. Other interviewees accepted that in certain situations an expert may have sent an assistant to obtain the raw data but must have performed the analysis him or herself. This practice was commonly acknowledged in respect of acoustic engineers who may take noise measurements at intervals throughout the day and night. Some members were adamant that evidence could not be based on analysis of a literature search because the expert had no direct knowledge of the subject matter. This requirement is linked to common law rules concerning the admissibility of expert evidence, although these rules are not binding on the environment court (Freckleton & Selby, 1993). For other members, however, not only would a thorough analysis of literature be acceptable, but also an analysis of data proffered by an expert engaged by the opposing party. This diversity of expectation is worrying because there is no obvious way that a given expert could appreciate the requirements of the court regarding the expert's methodology. In addition, criticisms about methodology were not only leveled at newer experts. Sometimes very experienced experts were criticized for presenting their evidence in the same way that they had always done but with less personal involvement in the collection of their evidence than another expert in the same field. In respect of methodology, it is clearly necessary that the court develops its own consistent policy, but that policy should be informed by the members of the various professional groups that represent scientific and technical experts. In turn, technology and science educators have a role in grounding students in sound research methods and practices and in contributing to the continuing education of those people who are outside the technology or science communities but who encounter the personnel and subject matter from those communities on a regular basis.

Implications for Technology Education

The preparation and presentation of an expert opinion is an important and common aspect of the working life of many technologists. It is natural that decision makers in a range of different arenas will require expert technical advice concerning a multitude of different proposals and issues. I suggest that educators should have a role in preparing students to face a variety of situations in which their expert opinion will be under scrutiny. This view was also expressed by several members of the environment court as follows: "…the new, young planner straight from graduate school… isn't fully given to understand what is his or her role, and the failure is on the part of graduate schools." [Commissioner]

Technology education must emphasize the importance of effective communication at two different levels. First, students of technology need to recognize the importance of communication during all stages of their development. Effective communication requires recognition of the expectations of the intended audience (Nelkin, 1996). For many students of technology that audience may at times be a court of law. Although the environment court has differences in its expectations of experts, the qualities of independence, clarity, and depth of understanding were approved by all interviewees. Those qualities could easily be incorporated into technology education by encouraging students to present interactive seminars to explain their work. The notion of independent expertise could be developed by having students present interactive seminars based on each other's work. The notion of an interactive

seminar would promote the need for clarity, consistency, and depth of understanding, which were all valued qualities of expert witnesses.

At a second level, there is a role for technology educators to provide continuing education to those lay people who regularly assess information provided to them by experts. These lay people may be members of a legal forum such as the environment court or they may be members of local authorities, governmental organizations, or other decision-making bodies. While my research has focused on a relatively small court in New Zealand, it is likely that these results will be transferable to other courts and other countries. The environment court hears a lot of very technical evidence, and its specialist nature is part of the reason for a combined legal and lay composition. Thus decision-making bodies that are constituted without any specialist technical expertise are likely to be less familiar with the framework and methods of technology as a curriculum component. Most of these people will not have had the benefit of any technology education and their views will reflect their own personal educational and practical experiences. It is likely that they will use language in different ways to each other and may view the role and experience of the experts who proffer advice quite differently from each other and from the experts. Thus, there is a role for technology educators to work with decision makers to develop appropriate criteria for assessing expert opinion evidence and to communicate the goals and methods of technology studies as distinct from science and other educational frameworks that may be familiar to those decision makers.

Modern legal decision makers regularly hear a large amount of expert evidence from a wide range of disciplines and in relation to a wide range of issues, including environmental, criminal, and commercial matters. Many of those experts proffer technical evidence that concerns aspects of design, manufacture, and use of technological developments. It will be a serious flaw in technology education if that evidence is not successfully communicated in the legal environment because of a mismatch between the expectations of decision makers with those of expert witnesses.

Ms. Joan Forret is an associate with legal firm Harkness Henry and Co., based in Hamilton, New Zealand.

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