Exploring learners’ conceptions of technology

Brandon I. Collier-Reed
Department of Mechanical Engineering, University of Cape Town, South Africa
brandon.reed@uct.ac.za

This article reports on an empirical investigation into the different ways that learners conceive of technology. Fifteen learners, selected to ensure variation with respect to their socio-economic backgrounds, were interviewed around photographs that they had taken with a disposable camera. The photographs were taken of what they perceived to be important representations of what technology meant in their daily lives. The interviews were analysed using a phenomenographic approach to obtain an understanding of their conceptions of technology from their perspective. The outcome of the analysis was a set of categories that characterise the key aspects of the different ways in which technology is conceived. The findings show that learners conceive of technology (in increasing complexity) as an artefact, the application of artefacts, the process of artefact progression, as using knowledge and skill to develop artefacts, and as the solution to a problem. The article argues that it is only by teachers including a focus on ensuring that learners develop a more complex understanding of the nature of technology that the outcomes of the Technology Learning Area can truly be achieved.

Introduction

In the National Curriculum Statement R-9, technology is defined as ‘the use of knowledge, skills and resources to meet people’s needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration’ (Department of Education, 2002, p.4). This definition is similar to that used by a number of other organisations around the world, notably the International Technology Education Association (ITEA) who describe technology as ‘human innovation in action… [which] …involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities’ (ITEA, 1996, p.16) and the National Academy of Engineering (NAE) who describe technology as ‘the process by which humans modify nature to meet their needs and wants’ (Pearson, Young, NAE, & NRC 2002, p.13). It is not only academies, associations, and governments who share this broad view of the nature of technology, but also the philosophers of technology (see for example de Vries, 2005; Mitcham, 1994).

This view of technology underpins the three learning outcomes that form the core of the technology learning area in South Africa, namely: technological processes and skills; technological knowledge and understanding; and technology, society and the environment. However, this ‘definition’ of the nature of technology should be seen as the ‘expert’ or considered view as there is evidence to suggest that this is not what the typical individual understands by the meaning of technology. For example, in 2001 and 2004 a Gallup survey was undertaken to assess what North Americans think about technology (Rose & Dugger Jr, 2002; Rose, Gallup, Dugger Jr, & Starkweather, 2004). More than two thirds (68%) of respondents (similar in both surveys) said that the first thing that came to mind when they heard the word technology was computers, while the next highest response was electronics at
5%. In defining technology as ‘computers’ in this way, only limited aspects of the ‘expert’
deфиниція are embraced and focus is simply on a single technological artefact or outcome.

It is quite likely then that the ‘expert’ definition might not be the one espoused by learners. A
teacher could assume that the Gallup artefact-focused definition may likely be most prevalent
in a classroom, but given the socio-economic context in SA you could likely expect some
other definitions present. Thus, there would in all probability be a range of understandings of
the meaning of the nature of technology in any one class. The people interviewed for the
Gallup survey had been exposed to formal technology education in their K12 system of
education, yet still reflected a naïve view of the nature of technology. This paper presents the
results of an empirical investigation into how South African learners conceive technology.
These results are used to underpin a discussion into the consequences that could arise from
not recognising the possible multiple ways of understanding just what technology means
during the development of curricula for the technology education learning area.

-  **Methodology**

  **Research approach**

  This study sought to obtain an interpretive understanding of learners’ conceptions of
technology. A central aspect of this research was that it set out to investigate these
conceptions from the perspective of the learners themselves. Phenomenography (Marton,
1981; Marton & Booth, 1997) is a research approach that fulfilled these requirements and
was used for this study. Phenomenography aims to describe the key aspects of the variation
of the experience of a phenomenon (in this case technology) rather than focus on the richness
of individual experiences. A critical assumption of phenomenography is that it is possible to
characterise variation in the experience of a phenomenon in terms of a limited number of
qualitatively different, logically related categories (Marton and Booth 1997).

  The process of analysing the data collected (typically from interview transcripts) involves
disaggregating the data into sections of text, each containing specific reference to where a
particular experience of a phenomenon is focused on. All the sections that have been
extracted from the data are first interpreted in relation to each other, and secondly in relation
to the interviews from where they came, i.e. their original context; and then iterating between
the two. The process of iterating between the collection of sections and the original
interviews is an attempt to bring to light critical aspects of these ways of experiencing. As a
result, even though the categories that emerge from the analysis have essentially been lifted
out of the original context, the constitution of the categories was not undertaken in a
decontextualised manner.

  The outcome of a phenomenographic study is a set of categories that characterise the key
aspects of the different ways in which an experience can be described. One of the differences
between a phenomenographic analysis and a more conventional qualitative analysis is that
there are logical relationships within and between categories. The categories each have a well
defined structure and are collectively often hierarchical in nature reflecting an increasing
complexity in terms of this logical relationship. The nature of the categories is important and
Marton and Booth (1996) indicate that categories need to fulfil three criteria for the research
approach to qualify as phenomenographic. The first is the requirement for the categories to be
logically related. Another requirement is that they are parsimonious, i.e. the minimum
number of categories that fully describe the different ways of experiencing the phenomenon
must be used. Finally, each category must completely describe a distinctly different aspect of
the experience of a phenomenon, i.e. each category must be qualitatively different from the
others.
Method

As noted above, the outcome of a phenomenographic analysis is categories describing the variation in the ways a phenomenon can be conceived. By implication, it is important to ensure that the participants selected are appropriate to enable this variation to be as comprehensive as possible. The most suitable way of accomplishing this is to select a number of what a researcher considers ‘critical cases’ to ensure as much variation as possible. With this in mind, data were collected from 15 learners at three schools in the Western Cape. The first of these schools was located in the heart of one of the elite suburbs in Cape Town. It was not a private school, but was exceptionally well resourced and serviced a number of nearby high-income residential neighbourhoods. The second was a school originally founded to educate the children of farm labourers and now services an economically depressed suburb on the Cape Flats where learners are driven to and from the school by bus every day. The third school was located in the heart of a local township where poverty is rife and unemployment levels high. The school itself was fairly well resourced, but the background of the learners reflects the community in which the school is located.

After a learner had accepted the invitation to participate in the investigation, they were given a disposable camera to take a number of photographs of what they perceived to be important representations of what technology meant in their daily lives. These photographs were processed and printed prior to each interview session that took place. Having learners take photographs was a way of helping to ensure that the interview centred around a shared experience of the phenomenon and thus there was a greater likelihood of ‘establishing a joint definition of what [was] being talked about’ in the interview situation (Säljö, 1996, p.23-24). All the interviews took place with individual students on school premises during school hours and were recorded using a digital recording device. The interviews were transcribed verbatim.

Findings

From the analysis of the data, five qualitatively different categories emerged. These categories form a logical hierarchy of increasing complexity (from A to E) in the way learners conceive technology:

A. Technology is conceived of as an artefact;
B. Technology is conceived of as the application of artefacts;
C. Technology is conceived of as the process of artefact progression;
D. Technology is conceived of as using knowledge and skill to develop artefacts; and
E. Technology is conceived of as the solution to a problem.

In the following sections, the characteristics of each of these categories are briefly described. Extracts from interview transcripts are used to illustrate particular aspects of each category. For each extract used, questions asked by the interviewer are shown in bold and the responses by the learners are in regular font. In the responses, what are considered key phrases are italicised. As typical in a phenomenographic study, illustrative extracts cannot necessarily encapsulate the fullness of a category, but rather can only illustrate critical aspects of a category.

Category A: Technology is conceived of as an artefact

In this category, technology is described in terms of being some physical, tactile thing. It is characterised as involving artefacts that have particular qualities or features. Examples of
these would be bolts and screws in a security gate; cords, wires and plugs on appliances; appliances that are remote controlled; etc.

The following extract shows an artefact conceived of as technology because of the fact that there are many wires and cords attached to it:

*My overhead projector.* It’s the same thing. There were lots of cords and wires and it’s especially, *you can see all the wires*, which made me *think technology straight away* when I saw it.

Interestingly, the removal of some of these constituent parts from the artefact results in an artefact that is no longer conceived of as technology:

*So if you had to take out the motor, out of the washing machine and [take] out the wire and toss it on a scrap heap, will it still be technology?*

… *No, not technology*, it will just be a box, *just a box.*

**Category B: Technology is conceived of as the application of artefacts**

While the emphasis of this category remains on artefacts, the central focus is on the *use* of those artefacts for a purpose. This *use* of technology is to *achieve* something or, put another way, the application of an artefact to have something happen. In a sense, artefacts are now seen as ‘active’ as opposed to the passive nature of Category A that was dominated by the qualities and characteristics of the artefacts themselves.

In this category, the fact that an artefact is used for a purpose is important. Technology has a function and typically, an artefact is dependent on this function for its existence. The following extract is in response to a question about why a door lock is technology. As in Category A, the character of technology relates to the properties and qualities of artefacts, but now there is an associated action:

*The gears*, the way it works for instance *you turn the key* it’s just not turning the key you *are putting levers together*. You are making it move.

An artefact is not considered technology unless it is in operation (or use). This use results in an impact on the individual. This is clearly illustrated in the following two extracts:

*If* [the amplifier] *was just sitting there*, I think to me, *when it’s actually switched on then that’s technology*, because if it’s something digital or something like that you switch it on, it says like power on or loading or something to that effect then that to me would be technology.

**Category C: Technology is conceived of as the process of artefact progression**

The first two categories of technology had technology as an artefact and the use of that artefact as central. The critical difference between Categories A and B on the one hand and C, D and E on the other is that in the latter, technology is something that occurs or happens. In Category C, artefacts evolve (or progress) through a process, where *process* is taken to mean a series of actions, changes, or functions that bring about a result (Ilson, 1987). This category is distinct from Category D in that in Category C, there is no focus on *how* or *by whom* these artefacts evolve, simply that they do.

A typical example of the critical aspects of this category is shown in the extract below. The focus is still clearly on an artefact, and the use of that artefact, but now there is an additional aspect that this artefact has progressed over time. Even though the nature of the artefact itself may be changing, focus is still on the use of the artefact. The extract below is in response to a discussion about the result of an artefact (in this case an oil-can spray) ceasing to be useful:
For it to be where I think technology should be, it should have the ability to progress and carry on moving. So this, it’s, if its function is met, other than just applying oil, that’s fine, but if, if it was something that had the ability to move on, [and] it wasn’t, then I think that’s bad in terms of, that’s not where I think technology should be, but here, it’s okay, because it’s still performing its function and people still use it, even though it’s old.

Category D: Technology is conceived of as using knowledge and skill to develop artefacts

Both Category C and D have in the foreground an emphasis on the evolution or development of artefacts. In Category C, this process is undefined whereas in Category D it takes place by people using their knowledge and skills. These people have a plan and there is a purpose for what they are doing. Category C can be interpreted as a ‘passive’ and Category D as an ‘active’ process of artefact change where there is now focus on an interrelationship between form and function and the process people used to get the artefact to its present condition. The essence here is design for purpose.

In this category, the focus shifts from being related to the artefact itself (as it was in Categories A, B and C) to the process of developing an artefact. The following extract is in response to a question about why a photograph of a computer as technology was included:

People had to like test to see how it worked and like went through a process in order to like get to what they had over there, I think that technology is basically a process. You must have an idea and then your planning and your research and the making of it and then the evaluation.

However, it is more than simply the development or evolution of an artefact that is important, it is the fact that a person used knowledge and skill to do so. It is this ‘human factor’ in the development of the technological artefact that distinguishes this category from Category C. The individual as simply a user of technology is no longer in focus, but rather that people are developers or evolvers of technology. There is the realisation that they (the learners and others) are all ‘technologists’. The following extract further illustrates this point. In this extract, the use of the term ‘you’ is not personal but refers rather to people in a generic sense:

It’s just that as time went by things got a bit smaller and that’s to do with like the technological process of making things more, improving them.

This technological process, what’s that?

It’s like, how can I say, it’s like, this idea that you put into place, say for example you have this idea of making something and you put this idea onto paper and you like go through the steps of like making it, like you have like your plan of how to do it, and how the actual making takes place and your evaluation of it, like your results, your testing after, whatever, that’s what I’m saying.

Category E: Technology is conceived of as the solution to a problem

In Categories A to D, the artefact per se was progressively moving further away from being central to the conception of technology. In Category E, focus is not specifically on an artefact at all, but rather on technology being the solution to a problem faced by humans in their lives. This solution can be in the form of an artefact, but is not necessarily so.

Central to this category is the idea that it is no longer the development of an artefact and the use of this artefact to do something, but rather the recognition of a problem and the solution to that problem. For example:
Someone had a problem and so they made this solution to get from A to B, and they built a road, or wheel or a boat and these are just sort of modern advancements on the old ways.

This category is further illustrated in the following quotation where focus is on the design of the solution to a problem which directly impacts on quality of life:

‘Ja’, it helped, you know, before we had to use candles once again and then obviously, someone thought about this and they designed it and they made it and they helped solve a problem, which is what technology does, or they improve something, ‘ja’.

Discussion and concluding remarks

The DoE (2002) states that the purpose of the Technology Learning Area is to help develop learners’ technological literacy by giving them opportunities to, amongst others, “develop and apply specific skills to solve technological problems [and] understand the concepts and knowledge used in Technology” (p.4). In order to achieve this, a fundamental assumption must be that the learners in a classroom have a common understanding of the meaning of technology – and not one that says that technology and computers are synonymous as reflected in the Gallup studies (Rose & Dugger Jr, 2002; Rose et al., 2004) referred to in the introduction. For learners to simply adopt a view of technology as being synonymous with computers has the potential to be disempowering as there is nothing of the people involved in the process that is present to them. The results presented in this paper show that within any classroom, there will be a range of ways that students conceive of technology – and not all of them are useful in the context of their technology education.

It is argued that together with engaging with learners around the technology learning outcomes, a teacher needs to dedicate time to explicitly develop in learners a fuller, or more complex, understanding of what the nature of technology is. Looking at the core content areas as defined in the Revised National Curriculum Statement (DoE 2002), it would appear feasible to structure activities to integrate this development of an understanding of technology into the curriculum followed in the classroom. It is only by teachers including a focus on ensuring that learners develop a more complex understanding of the nature of technology that the outcomes of the Technology Learning Area can truly be achieved.

References

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