What is technology education?

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Introduction

The question posed in the title of this paper has a strong affinity with the title taken from Deleuze and Guattari's book entitled *What is Philosophy?* In this book, they suggest that there is too strong a desire to *do* philosophy, rather than wonder what philosophy is. In the same way, I believe that in terms of technology education, there is too strong a desire to *do* technology education, rather than to consider what technology education is. Philosophy for Deleuze and Guattari, "is the art of forming, inventing, and fabricating concepts" (Deleuze & Guattari, 1994, p. 2). Synonyms for concepts include ideas, images, thoughts, visions and perceptions. A concept is a plan, an invention a mental image of something. If we consider technology education in like terms, the formation of ideas relating to technology can lead to the invention, design or evolution of a technology, which may then be fabricated or actualised in some form. However, we are reliably informed by current official documentation relating to technology education, that whether craft-based or literacy-based, technology education is very much about solving problems. We are further informed that technology education is inextricably linked with engineering, as is now made manifest in the rebranding of the subject by integrating it with Science, Engineering and Mathematics. This new conceptualisation forms what is now known as STEM education. Solving problems is, thus, a concept embedded in a technology education paradigm associated with designing engineering projects to solve problems. But if technology education is about forming, inventing and fabricating ideas, which is essentially a creative process, solving technological problems must, *ipso facto,* also be a creative process.

Deleuze and Guattari very much link forming, inventing and fabricating ideas with creative thinking. It is, they say; "the creation of thought[1], [where] a problem has nothing to do with the question [*what is the problem?*], which is only a suspended proposition[2], the bloodless double of an affirmative proposition[3] that is supposed to serve as an answer (Deleuze & Guattari, 1994, p. 139). This infers either that solutions to problems are value-laden and so subject to disputation, or that they have a precise and well-defined answer or solution. Either way, any answer to the question, 'What is the problem?' depends upon which of the two definitions is adopted.

The trouble with answering the question 'What is technology education?' is that there is no precise and well-defined answer. This is attributable, in one important respect, to the breadth of subject domains that exist in technology education today. These vary across the world but may include woodwork, metalwork, working in plastics, technical drawing or graphic communication, CAD, electronics, pneumatics, mechanics, design or learning about the concept of becoming technologically literate. Each of these subject domains tends to be taught independently from one another and assessed likewise. You cannot teach and assess technical drawing in a woodwork or metalwork classroom setting. This particular issue has now become further confused with the introduction of STEM education.

What constitutes a problem in technology education?

Before answering this, we must first consider the following questions regarding school-based technology education. Who is it that decides what constitutes a problem, who decides how any problem should be solved, and what the 'correct answer/solution' should be? Must the problem posed align itself with curriculum documentation? Does the student resolve the problem independently, or do students work

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[1] The creation of thought is the act of thinking thoughts that have never before been brought to light. For Deleuze and Guattari, it is the creation of concepts or ideas. It is not remembering stuff that has already been thought.

2 A suspended proposition cannot be checked or proven. It has no referential base from which to verify its validity. To propose that STEM education at school leads to engineering qualifications, is a suspended proposition.

3 All cats meow is an affirmative proposition. All swans are white was considered to be an affirmative proposition until much later when black swans were discovered in Tasmania. Affirmative propositions in school education rely on what is considered to be right or wrong answers. The trouble with assessing right or wrong answers renders the question 'what is the correct answer to the colour of swans?' complicated.

collaboratively? Finally, and perhaps most importantly, how is any solution assessed, and who assesses it? The outcome of any problem-solving learning scenario will depend upon the perspectives held by those in power who answer these questions. Hidden between folds of these answers lies the question of which style of pedagogy will then be employed in the delivery of the problem-solving activity. This then leads us on to the question, what constitutes a problem to be solved in technology education?

Let us consider two specific types of problems that can require solving in technology education. Differentiating between the two is essential[4].

The first type of problem is what I term 'embodied applied problem-solving'. In this model, solutions are known in advance and must be applied or re-applied. Embodied applied problem-solving is when a problem reveals itself, when it makes itself known. It arises when some disturbance takes place that requires some action, often immediately, by some expert in the field who already knows how to resolve it. Examples include a burst water pipe requiring the ministration of a plumber or engine failure in a vehicle requiring the assistance of a car mechanic. Embodied applied problem-solving is actually embodied applied problem-repairing or reproducing. No one would ever dispute that the Mona Lisa, painted by Leonardo da Vinci, is a truly creative artwork. A reproduction, on the other hand, even if painted by an expert forger, is no more creative than painting by numbers. The forger is clearly technically skilful, perhaps even as technically skilful as Leonardo himself, but the forger is not creating. She is reproducing; she is copying.

The second type of problem is what I term 'virtual creative problem-solving' or problem finding in Deleuzian terms. It relies upon the possibility of creating something original, something new, something never created before. It is a problem that does not reveal itself like a burst pipe or a forest fire for example. Rather it is a problem that does not yet exist and must be invented. To invent something is to create something new. Problem-finding begins with creative thinking as a process in the creation or invention of something unique. In this sense, problems become a series of virtual ideas that must first be designed or invented in the mind, before any solution can become actualised. It involves an ongoing circular process of innovation, experimentation and critique. Only then can some solution be found that eventually becomes actualised.

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4 It is important to note that craft-based technology education, especially when it is aligned with engineering, is fundamentally different from the craftwork of an artist.

Virtual creative problem-solving in engineering can be exemplified by considering the design of the ring pull can. Whilst devices to open cans already existed, the birth of a ring pull can was initiated virtually, as a process of creative thinking. This process would have been thought, amended and rethought in a continuous loop until an actualised prototype was fabricated. It was not a copy of what had gone before but a novel variation.

Now, here is the irony: most of the current curriculum documentation for technology education implies that creativity (the development of which is another stated requirement), must be seen to play a dominant role, mainly because it relates more closely to the design process. However, there is a difference between designing a bridge and working on the construction of a bridge. Likewise, there is a difference between designing and repairing a car or a house. A plumber, construction worker or car mechanic requires specific fabrication and repair knowledge and expertise. They must, over time, attempt to develop the skills necessary to work with the tools and materials associated with their trade. They must evolve from being novices to becoming experts, who, according to Dreyfus, "not only sees what needs to be achieved; thanks to [their] vast repertoire of situational discriminations, [they] also see immediately how to achieve their goal" (Dreyfus, 2001, p. 41). An expert in any craft-based skill appears to produce something without thinking. Their expertise is almost magical to observe.

In contrast, car and bridge designers require different skills, including the ability to think novel designs. (Challoner, 2011), for example, wrote an interesting book listing 1001 inventions that changed the world. That is not to say that one skill set is superior to the other—quite the contrary. They constitute different abilities requiring different skill development and, in terms of education, different pedagogies for learning.

Structural engineers, transport engineers, mechanical engineers, product designers and architects, to name but a few, design three-dimensional structures, whether buildings, roads or artefacts. They have different skills from those who construct or fabricate them. They all must be aware of how their designs can be made manifest, but it is not a requirement that they themselves are able to fabricate them.

Whilst there are those who do create, design and fabricate artefacts, in most cases of engineering or architectural disciplines, creative design is carried out by one set of professional engineers or architects, whilst fabrication is carried out by expert artisans. Thus, any building, road or artefact relies upon variations of collaborative processes of various disciplines which will be different for all new projects. Deleuze refers to this as a multiplicity. In this sense, a multiplicity is a dynamic event having no beginning or end. It is constantly changing. The design and fabrication of a motor car serves as a good example. A wheeled and powered transport system existed long before Karl Benz invented the motor car. Transporting goods and people has existed for millennia, so pinpointing a beginning is always challenging, as is determining an end. Early wheeled transport systems called carts or carriages were powered by horses. The power of combustion engines in motor cars today is still measured in horsepower but no longer requires actual horses. Who knows what transportation will be like in the future? One thing is certain, every technology will continue to evolve substantively and, in so doing, change in its nature.

Notwithstanding, taking Karl Benz's first motorised vehicle as a starting point, the motor car has undergone many changes over the years. Look up automobile timelines online, and they resemble timelines for any other product. They are straight lines with starting and finishing points punctuated with sequential developmental events, suggesting a progressive, linear evolution. Timelines produced thus suggest a series of static, separate event changes.

However, when the automobile's ongoing evolution is considered in terms of what Deleuze refers to as multiplicities, it changes the linear timeline perspective from a series of sequential static events to a dynamic chaotic process of movement and energy. The change from a petrol or diesel-fueled automobile to becoming an electric car represents one multiplicity, bifurcating into becoming another multiplicity. Whilst there is a total change in the nature of one over the other, they are still collectively known as automobiles. There is consequently "no essence of particular multiplicities which can remain unaffected by others” (Roffe, 2010, p. 182).

Evolution in automobile design becomes a process whereby many virtual design processes lead to significant virtual design changes, many of which are discarded until one is developed, and proceeds to become actualised, often as a prototype. Technological design thus requires the study of past successes and failures in order to design the future.

Learning as Embodied Applied Problem-solving.

Deleuze tells us that "[w]e are led to believe that problems are given ready-made and that they disappear in the responses or the solution" (Deleuze, 2004, p. 197). This belief manifests in any technology education setting where the teacher or the curriculum sets a problem for the students to solve, usually independently. The result is accredited true or false by some examining body, often external to the school.

As a result, there is a tendency in technology education delivery to think that problem-solving begins with well-defined problems set by curriculum developers or teachers, all of whom already know the answers/solutions. Following the embodied applied problem-solving route, these problems, having been resolved beforehand, now need to be re-solved by students. The closer the students get to reproducing the already established solutions, the higher the grade they achieve. Posing pre-established problems does not result in new solutions to old problems. Problems can only be solved once. Otherwise, they become new problems deserving of new solutions. In this model of teaching and learning, pedagogy reverts to the transmission of pre-existing knowledge from expert to learner. Bogue argues that:

> Thought's goal in a world of recognition and representation is to eliminate problems and find solutions, to pass from non-knowledge to knowledge. Learning in such a world is simply the passage from non-knowledge to knowledge, a process with a definite beginning and ending, in which thought, like a dutiful pupil, responds to pre-formulated questions and eventually arrives at pre-existing answers (Bogue, 2008, p. 7).

Rather than eliminating problems by way of some pre-established solutions, Deleuze, on the other hand, asks that we consider problems as being:

> independent of the questions and solutions stored in memory. It is a problem because it does not yet have a solution and because it will never allow for solutions that cancel it out ... a problem is something inevitable ... that can only lead to a series of creative reactions rather than to a lasting solution (*I cannot know the answer to this. My imagination must go beyond my memory* (Williams, 2003, 2013, pp. 129-130) (italics in original).

When learning in a technology education setting is achieved along a linear pathway from non-knowledge to knowledge, it indicates that the knowledge already exists. Moreover, knowledge, in this paradigm, is a matter of knowing how to do something (procedural knowledge) or knowing that something is or what it is (declarative knowledge). These types of knowledge exist in memory, a faculty of the mind that enables the storage and retrieval of information, whether procedural or declarative. Deleuze refers to problem-solving in this respect as 'false problem-solving'. As Williams suggested above, going beyond memory requires problem-solving to become creative and experimental. It can no longer be anchored to higher truths or pre-existing solutions (Wasser, 2017, p. 54).

Learning as Virtual Creative Problem-solving.

Since Aristotle and Plato, we have come to accept the world we know as being a relatively stable and objective reality that we understand and know in varying degrees. For Aristotle, in his categories, we have, in straightforward terms, two sets of beings: living beings and non-living beings. So, rocks are non-living, whilst animals, plants and trees are living beings. The genus 'animal' is subdivided into species: for example birds, fish, tigers and humans. Humans are uniquely differentiated from all other animals by being considered rational animals. Individual humans can be further differentiated from each other definitively and quantifiably, as being male and female, child and adult, black and white, for example. Deleuze, however, rejects Aristotle's categorical differences by arguing that they offer too simplistic a perspective. James Williams, a renowned Deleuzian scholar, puts it thus:

> He [Deleuze] constructs it [his opposition] around the definition of difference as that which sees things in movement and that which can only be approached by resisting thought in terms of the proper and in terms of the categories (*Where else could it belong? What if we think of it as something else? In what way can we make it fall outside its proper category?)*. So, differences between things, based upon which sets they belong to, are not essential or primary differences. Instead, the tangible difference is a matter of how things become different, how they evolve and continue to evolve beyond the boundaries of the sets they have been distributed into *(It is not what you are or what this is, it is what you are becoming and why this becoming is significant for others and other things)* (Williams, 2003, 2013) (italics in original).

Consider asking, 'Is the female different from the male?'. Under Aristotle's categories, the answer would be most definitely, yes. Under Deleuze's concept of difference, however, he opposes what he calls Aristotle's 'difference in degree' from what he refers to as the 'difference of nature or kind'. The female has certain characteristics of sex that can be determined quantitatively, as has the male. However, they both have gender complexities that are qualitative. This also applies to technologies. Is a hammer still a hammer when it is used as a paperweight or to hold a door open? Elizabeth Grosz explains:

> Differences in degree, which he [Deleuze] construes as differences of magnitude, quantitative differences, differences of more or less, measurable differences; and differences of nature or kind, which are qualitative, differences, impossible to measure or describe in numerical terms but discernible in and for

> conscious mental life and experienced in the continuity and ever-changing movement of duration. If quantitative differences are measurable, they indicate spatial differences, differences external to each other, differences between things, differences that can be marked or characterised through their coordination with a third term, a number, that is, through measurement. Such differences are discrete, discontinuous, and homogeneous. They can be divided in infinite ways without transforming their nature.
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> Differences in kind, by contrast, can be construed as internal or constitutive difference, continuous, heterogeneous, interpenetrated, without clear-cut outlines or boundaries, and incomparable with each other or with a common measure (Grosz, 2004, pp. 158-159)

It is in this sense that school assessment becomes complicated. Summative assessments in the form of tests are hierarchical. In other words, some external agency decides what a student should know and designs a series of problems to test whether the student knows everything that the curriculum expects them to know. These problems are predicated upon a quantitative analysis of the expected body of knowledge and craft-skill development that the student has reached. More and more written tests are designed around multiple-choice questions, where the 'correct' answer is hidden amongst four or five 'incorrect' answers. These tests are linked exclusively to the age of the child. In other words, all 11-year-olds will know 'X'; if they do not, their future transfer to the next stage in their schooling may be in jeopardy. This type of problem-solving in order to measure 'learning' is antithetical to Deleuze:

> We never know in advance how someone will learn: by means of what love someone becomes good at Latin, what encounters make them a philosopher, or in what dictionaries they learn to think. The limits of the faculties are encased one in the other in the broken shape of that which bears and transmits difference. There is no more a method of learning than there is a method for finding treasures, but a violent training, a culture of *paideïa* which affects the entire individual (Deleuze, 2004, p. 165) (italics in original).

Paideïa is, thus, not learning about development and formation, such as is made possible by what the State considers to be economically viable embodied knowledge and skills, skills that are inserted into the minds and bodies of students through the ministrations of expert bodies. What Freire calls the 'banking method' of education. Theoretically, put knowledge in, get knowledge out, hopefully with some interest. The concept of païdeia, in terms of education, is a transformational process through guided self-cultivation, self-development and self-formation.

Conclusion

Learning in technology education should, as I have argued elsewhere, also involve subjective acts carried out when one is engaged in the formation and realisation of new ideas about technology. However, in reality, this continues to prove difficult, if not impossible (Dakers, 2023). The dominant orthodoxy in technology education remains fixed in the embodied applied problem-solving paradigm of learning skills associated with realising preordained rule-driven solutions. This vocationally orientated paradigm considers technology education to be a subject that requires students to develop the skills considered necessary for industry. This infers that these 'necessary' skills must be known in advance, thereby enabling the creation of prescribed curriculum content in service to industry. Research in secondary school technology education indicates that vocationally orientated craft-based technology education classroom practice overshadows the delivery of the creative aspects of virtual creative problem-solving.

My conclusion to the question 'What is technology education?' relies entirely upon the worldviews held by those responsible for the design of its curriculum content and for the delivery in the classroom. Experience dictates, at least for the present as well as for many other complex reasons, that the subject is locked into a quantitative pedagogy, a 'curriculum-as-plan' as Aoki (Dakers 2023, p.41) argues, where the curriculum content is specified in advance. This pre-supposes a pedagogy of the transfer of knowledge from teacher (expert) to students (passive recipients). What is needed, instead, in my worldview, is the formation of 'a-curriculum-of-lived-experience' (Aoki in Dakers 2023, p.41) where these issues are discussed and debated openly and democratically; one in which no individual is in charge of the knowledge that is co-produced and subject to constant variation (Dakers, 2023, p. 41).

As Bogue reminds us, teachers who say do this or do that are transmitting knowledge. On the other hand, teachers who say 'do with me' … are not providing students with answers to problems that have already been solved, but rather, are guiding them in the art of discovering problems, an art that can only be mastered by practising it. "Such practise is mysterious in its inner workings, and unpredictable in its effects. … [It is] not a method, but an art, not a programme of study, but a rigorous discipline" (Bogue, 2013, p. 31). It is païdeia.

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