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Adult numeracy – a paradigm shift?

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I present the ground-breaking theories about scientific revolutions by Thomas Kuhn and his development of those theories, particularly the concepts of incommensurability and lexical change. I review the long-standing theoretical discussion about adult numeracy and the extensive attempts to reach some agreement upon which to build a research domain alongside mathematics education research. I propose that Kuhn's conceptual analysis can be applied to the emergence of adult numeracy out of the field of mathematics education research to form a new paradigm of education research.

Keywords: Numeracy, paradigm, incommensurability.

Introduction

I will summarise the development of Thomas Kuhn's theory in the 30 years after the publication of *The Structure of Scientific Revolutions*, (1962) particularly in the works published as *The road since structure* (Kuhn, et al., 2002) with reference to fluid lexicons and incommensurability. I will use these philosophical concepts to critique the repeated attempts to explain and define adult numeracy, and the many contexts in which mathematics is found wanting in describing an adults' numerate accomplishments.

My main proposal is to apply Kuhn's analysis of a scientific revolution to the emergence of adult numeracy in the field of mathematics education research. Subsequently can I use the resultant research process to establish adult numeracy as a discipline in its own right and initiate further research along similar lines? The hope is that such research can produce a body of knowledge that will transform how the majority of the adult population views numeracy education and practice.

Kuhn, scientific revolution, paradigm change

The concept of the paradigm and paradigm change is central to Kuhn's argument. Unfortunately, the term 'paradigm' has been much over-used (see for example Rogers, 2002, p. 487) and so it is worth looking at what Kuhn said.

The transition from a paradigm in crisis to a new one from which a new tradition of normal science can emerge is far from a cumulative process, one achieved by an articulation or extension of the old paradigm. Rather it is a reconstruction of the field from new fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalizations as well as many of its paradigm methods and applications. (Kuhn, 1962, p. 84)

This makes us realize that that nature of the change involved is deep, significant and conceptually challenging. In proposing the theory Kuhn sees a very significant role for the growing dominance of a new paradigm making changes to the direction of future research. He says "But paradigm debates are not really about relative problem-solving ability . . . Instead, the issue is which paradigm should in the future guide research on problems" (Kuhn et al., 2002, p. 156).

Revisit Structure –lexicon – incommensurability

In his later work, revisiting the theory of scientific revolutions and responding to the very many criticisms that were made of ‘Structure’ Kuhn puts greater emphasis on the use of language and the significance of a research community sharing ‘a core’. The introduction of two additional concepts, lexical change and incommensurability, make the theory even more applicable to the emergence of adult numeracy as a new research field, as I will show.

People who share a core, like those who share a lexical structure, can understand each other, communicate about their differences, and so on. If on the other hand, core or lexical structures differ, then what appears to be disagreement about fact (which kind does a particular term belong to?) proves to be incomprehension (the two are using the same name for different kinds). The would-be communicants have encountered incommensurability, and communication breaks down in an especially frustrating way. . . . What the participants in communication fail to share is not so much belief as a common culture. (Kuhn et al., 2002, p. 239-240)

Kuhn later clarifies what he means by a lexicon.

A lexicon or lexical structure is the long-term product of tribal experience in the natural and social worlds, but its logical status, like that of word meanings in general, is that of convention. Each lexicon makes possible a corresponding form of life within which the truth or falsity of propositions may be both claimed and rationally justified, but the justification of lexicons or of lexical change can only be pragmatic. (Kuhn et al., 2002, p. 244)

This theoretical approach begins to give us a vocabulary and philosophical approach to explore and explain the gulf that has opened up between adult numeracy education researchers and practitioners and others in the mathematics education world.

Revisiting numeracy – again

I have been involved in examining how numeracy has been used and defined in the particular context of Adults Learning Mathematics for twenty-five years and give for reference two conference proceedings. (Kaye, 2003 and Kaye, 2015)

This is continuing a discussion that takes place in every conference about teaching adults' numeracy (and mathematics). Making a strong connection with the tradition we are making in CERME here is a view of the situation by Kees Hoogland in his introduction to the papers presented at CERME 11. This both gives an overview and identifies some of the problems.

Although there is a broad acknowledgment that an array of psychological and sociological factors are important in (the results of) adult education, there is not yet a well-researched set of examples how in practice this can be taken into account in a more systematic and effective way. The practice of adult numeracy education is still a plethora of different content descriptions and goals that vary from very back-to-the-basics to very sophisticated higher-order skills. . . . The twin goals of trying to establish a firm definition of numeracy which acknowledges the multifaceted nature of adult's mathematical practices while identifying consistent teaching approaches should be of concern to the global AME community. (Hoogland et al., 2019, pp. 1298/9)

Two recent summaries published in 2015 and 2020 in the ZDM mathematical journal review recent research into numeracy. In the introductory paper by Geiger et al (2015) various statements about what numeracy is (or is not) are presented.

Although what is meant by numeracy varies between countries, it is now broadly accepted that being numerate extends beyond the mastery of basic arithmetic skills to how to connect the mathematics learnt in formal situations, such as school classrooms, to real world problems. (p. 531)

While there is an increasing focus on numeracy internationally, there is not yet a widely accepted definition for this construct or of the fundamental characteristics that describe this idea. Thus, the meaning of numeracy still varies widely across international borders . . . (p. 532)

This is followed by a section headed ‘Facets of numeracy’

The intrinsic usefulness of mathematics means that it provides a way of reasoning about, and functioning within, different societies with diverse social norms, values, cultures, and traditions. Unsurprisingly, this gives rise to related but distinct ways of conceptualising and identifying numeracy practices. (p. 535)

We see that numeracy is described as both an ‘idea’ and a ‘construct’; we see repeatedly stated that there is no agreement on what ‘numeracy’ means; and we find that ‘mathematics’ creeps into the descriptions, without being defined.

Another useful summary is the survey paper by Gal, Grotlüschen, Tout and Kaiser (2020). The title makes clear it has a focus on adults ‘Numeracy, adult education, and vulnerable adults: a critical view of a neglected field’ and provides its own definition of numeracy.

Adult numeracy is a construct related to the ways people cope with the many mathematical, quantitative, and statistical demands of adult life. Some definitions of *numeracy* emphasize basic computational skills or focus on emergent numeracy at a young age. In this paper, however, numeracy is used broadly to encompass a set of diverse skills, knowledge-bases, dispositions and affect, communication abilities, and practices and behaviors, that range from simple to very advanced, relate to mathematics and statistics, and that individuals need or use in order to engage and manage diverse life situations and tasks in the adult world. (Gal et al., 2020, p. 378)

Many similar definitions have been given over the years. Other researchers have looked at mathematics in other contexts and chosen alternatives to ‘adult numeracy’ such as ethnomathematics and indigenous mathematics. These fields have seen the debates around ‘numeracy’ as irrelevant (or a distraction) and have sought in other ways, and for other purposes, to redefine ‘mathematics’ and ‘mathematics education’. The use of these terms is part of the lexical change I am drawing attention to.

Ethnomathematics is summarized in this introduction to the topic group on ethnomathematics at ICME 13 (2016)

The application of ethnomathematical approaches allows us the opportunity to examine local knowledge systems and give insight into forms of mathematics used in diverse contexts and cultural groups. The pedagogical approach that connects this diversity of mathematics is best

represented by a process of translation and elaboration of the problems and questions taken from daily phenomena.

In addition, I also wish to reference the works of Gelsa Knjnick (2021) with the Landless Movement in Brazil and that of Marta Civil (2021) with parents from mainly Mexican origin in the USA.

These studies and investigations are often left out of the discussion around adult numeracy. They focus on presenting and defending the mathematics within particular cultures, which along with all other social, political, and cultural traditions and values have been suppressed. These need to be included as they too are trying to redefine mathematics education.

The mathematics of indigenous people needs to be noted too. One particularly powerful article is 'Mathematix: 'Towards a way of being' by Rochelle Gutierrez (2019) which presents the case of the mathematics (mathematix) of the indigenous peoples of North America.

In this paper, I seek to analyze some of the specific ways that Western mathematics in US schools operates as a form of dispossession and how mathematix addresses the need for Indigenous people to continue to remake themselves while interacting with non-Indigenous people. (p. 67)

Gutierrez later gives an example in which the relationship to, and naming of, geometric shapes is very different to the Western tradition.

For example, the word for square literally means "it squares itself" which is an action performed rather than an enduring property of the object. Ardoch Algonquin First Nation member and Anishinaabemowin teacher Marjolaine LaPointe recounts, I was thinking of this word, kakadeyaa, which means a square, but it's not a noun. It's a verb which means it's squaring itself. And kakadeyaa has this k sound, which is a cutting, a grouping, a separating, and when we break the language down into those sound-based parts, we start thinking in three dimensions as opposed to binaries of "this is this and this is that" and we see relationships between many things. (pp. 73-74)

There are numerous other examples drawing on indigenous numeracy (or 'mathematics') making a case to have a much wider understanding of what 'mathematics' might be. For example, the work of Linda Furuto (2018) on the traditions of Hawai'i and the Pacific Also the work of Marcia Ascher (2005), which deals with similar indigenous concepts outside of the education sector. And not forgetting the trail-blazing publication by Claudia Zaslavsky's 'Africa Counts' (1979) originally published in 1973.

What about mathematics?

As I have shown in this paper the concept, principle, practice and justification for 'numeracy' has been repeated many, many times. However, whilst 'numeracy' is explained in some way as doing something with mathematical concepts (or skills) 'mathematics' is very rarely defined. As Coben (2006, p. 21) has said "The nature of the relationship between numeracy and mathematics is elusive". Coben (2006, p. 21) noted that "'Mathematics' is taken to mean mathematics learned and taught at any level, including the most basic". Anecdotally, I re-call having a discussion about this with a group of trainee adult numeracy teachers and one contribution was (as I remember it) "Everyone knows what mathematics is – there is a degree in it". I have been thinking about this ever since and have

previously given examples of statements about mathematics, alongside those of numeracy, in a guide to teachers of adult numeracy (Kaye, 2013).

Numeracy, incommensurability and lexical change

I now return to the ideas of incommensurability and lexical change to argue that these need to be applied to using numeracy in the context of both adult education and people's lives. As has been shown there is a very strong research tradition that is comfortable with recognizing the importance of numeracy in adult education and many of those studies have arisen because of concerns about 'poor numeracy' in the adult population (O'Donoghue, 2000, p. 103). In fact, these concerns go back for about 60 years. All reviews of using numeracy speak of the Cockcroft report published in 1982, which in turn refers back to the Crowther Report published in 1959. Within paragraphs 35 to 39 of the Cockcroft report there is a discussion about the scope and range of 'numeracy'. As is the case in many official and research documents (on mathematics education) the target group is school children. However, as I have argued elsewhere (Kaye, 2018, pp. 11-37) once societal, cultural and political aspects of life are under consideration this is far more relevant to adult or lifelong learning, than school mathematics. What is important is that the argument is still the same between a 'small numeracy' or a 'big numeracy'. In the words of the Cockcroft report (1982) (emphasis in the original report):

We would wish the word 'numerate' to imply the possession of two attributes. The first of these is an 'at-homeness with numbers and an ability to make use of mathematical skills . . . The second is an ability to have some appreciation and understanding of information which is presented in mathematical terms, for instance in graphs, charts or tables or by reference to percentage increase or decrease. . . . Our concern is that those who set out to make their pupils 'numerate' should pay attention to the wider aspects of numeracy and not be content merely to develop the skill of computation. (Cockcroft, 1982, para. 39 p. 11)

The same discussion has been taking place ever since.

If the (adult) numeracy research community has been trying to fit numeracy practices into mathematics education and cannot find a 'good fit' then I think we have a conceptual problem of incommensurability. With a broad view of adult numeracy encompassing people's lives, including their work and cultural experiences, coming from every educational, class and ethnic background there is no common lexicon with a mathematics education built on the foundations of pure mathematics finding truth through logic and proof.

A new paradigm

There are indications that some researchers over the last twenty years have become aware of the need to question the current research domains and look for developments that establish what I consider is a new research paradigm.

In Jablonka's (2003, p. 87) section on 'Mathematical literacy for environmental awareness', a discussion about the fundamental nature of mathematical knowledge is introduced. It concludes "Consequently it is argued that mathematical literacy involves an attempt at changing the perception of mathematics towards a more human view in the hope that this may eventually even lead to the development of new forms of mathematics".

Coben (2006) published the article ‘What is specific about research in adult numeracy and mathematics education? She introduced a ‘professional knowledge domain’ and expressed her view of the current state of research.

Research in adult numeracy and mathematics teaching and learning is still in the exploratory phase of development. There is much conceptual uncertainty, manifested in shifting relationships between numeracy and mathematics and between numeracy and literacy, and reflecting similarly shifting relationships between these areas in educational practice. (Coben, 2006, p. 29)

In a later work on numeracy (and mathematical literacy) curricula Jablonka (2015) expressed a great deal of concern about the nature of assessment items used to measure adults’ levels of numeracy. Jablonka critiques how mathematics is contextualised in the numeracy/mathematical literacy assessments.

The incorporation of N/ML activities into mathematics curricula that specify mathematical knowledge in terms of generalisation and specialisation of *mathematical* meanings entails a recontextualisation that brings about a shift of criteria for what counts as an accomplishment of a task. This needs to be recognised in any attempt of inserting N/ ML activities into a *mathematics* curriculum (Jablonka, 2015, p. 606/7)

The reference to N/ML is to Numeracy/Mathematical Literacy and the italics is in the original. This again shows that trying to talk about adult numeracy in terms of ‘mathematical meaning’ brings about considerable confusion, most of which arises from ‘context’ in its broadest sense. In some ways it is not surprising as everything we have looked at so far emphasises that adult numeracy and numeracy activities and practices contain or are defined by ‘context’. Mathematics and traditional ‘mathematics education’ is considered context free. They are incommensurable as previously discussed.

Conclusion

This report presents a theoretical approach to research into adult numeracy education and practice. It uses the philosophical approach of Thomas Kuhn of the paradigm change, first described in the Structure of the Scientific Revolution (published in 1962) and subsequently developed over the next 30 years. The introduction of concepts like incommensurability and lexicon fluidity allowed this powerful analytical tool to be applied to the ongoing debate about adult numeracy. Combining this theoretical approach with a well-informed account of defining adult numeracy I have made the claim that adult numeracy research represents a paradigm change in the context of mathematical education research. There have been repeated attempts to explain and explore adult numeracy with the incommensurable lexicon of pure mathematics and its related educational processes, which have failed.

As Kuhn (2002, pp. 97-99) himself says this can only become really apparent if future research recognises the lexical divergence and with more and more researchers (and practitioners) using the new taxonomy, a new branch of education research evolves as does a new species through Darwinian evolution. A new habitat is defined where adult numeracy can grow freely.

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