

## **APPLICATION READINESS IN MATHS, AN ESSENTIAL CONCEPT**

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*The following article gives a brief account of some empirical research done in the 1980s in the UK by the present author with his colleague, Ibrahim Abdel-Ghany of Minia University, Egypt. At the time both researchers were working at the University of East Anglia at Norwich, England. This work is partly based on empirical arguments, and on conceptual analysis about the syllabus-worthiness of different kinds of targets and attainments in maths. The thrust of the argument is that it is essential that we teach children maths in such a way that they hold their knowledge of maths with 'application readiness' rather than 'application unreadiness'. The meaning of these terms will be explained in section three, after an account has been given of the nature of conceptual analysis and why it is needed. The article also describes some empirical research which established that in some schools in the UK children aged 10-11 years did not have their knowledge of elementary mathematics in a state of application readiness at the time the research was conducted.*

### **INTRODUCTION**

The nature and role of conceptual analysis (research) in education is briefly explained. The chief role for conceptual analysis in education is that of testing, by careful, systematic thought experiment, whether an item or items should be in the curriculum for schools (Pring, 2000; Barrow & Foreman-Peck, 2005). These 'thought experiments' involve the construction of detailed accounts of the likely consequences for individuals and society of having

item I or quality Q in the curriculum. Having described what is most likely to happen if item I or quality Q were in the curriculum (and was successfully acquired, as envisaged, by students), we can then bring ordinary commonsense judgments to bear on whether those consequences are socially desirable or not.

So conceptual analysis is really about finding the *full meaning* of 'I' and 'Q' when translated into the knowledge capabilities and capacities of young adults. This kind of enquiry may seem to lack the authority of empirical analysis, but this is a mistake, because most curriculum change comes about nowadays through political decision, and political decisions turn, almost always, on widely perceived meanings.

It might be thought that conceptual analysis gives rise to less secure conclusions than empirical research. This, though, is another mistake: because when we try to extrapolate *from* empirical findings about how a sample of children in a particular sample of schools responded to I or Q to "how all children in all schools will respond", we take an enormous risk. The teachers in the trial schools may have been enthusiasts for I or Q, and their enthusiasm may have communicated itself to the children. Conversely the teachers may have taken on the experiment in a lacklustre way and communicated their absence of feeling to the classes. Or the children may have been jaded and unimpressed with school in general, and therefore they may not have taken I or Q fully into their consciousness.

## **CURRICULUM REFORM IN THE 1970s**

There is the awful warning of the Curriculum Reform movement of the 1960s, which was triggered by a group of educationalists who met at Woods Hole in 1961. Thousands of projects were subsequently initiated in many countries during the 1960s and early 1970s. A huge amount of educational research of the empirical variety was applied to these projects and almost without exception it appeared

to show that they were *successful*. However we now know that by the end of that decade 99% of these projects had disappeared virtually without a trace.

The advantage of focusing carefully onto the *full meaning* of I and Q is that one is tacitly assuming that the teachers will transmit this 'full meaning' to their pupils. So conclusions which we can draw from the true meaning of I and Q will be fully applicable to cases where the quality of the teaching is high, but will be less applicable to schools which are muddling through with unskillful teaching. But conceptual research is not confined to 'bringing out' the full meaning of I and Q. The thought experiments which we do in conceptual analysis are involved just as much in searching for the right I and Q in the first place.

## CONCEPTUAL ANALYSIS

It may be asked whether conceptual analysis is really needed. Some people think that you only need a dictionary to look up the 'full meaning' of I and Q. This however is a mistake. The kind of Qs and Is onto which conceptual analysis focuses are not commonplace concepts like 'maths' or 'spelling'. Much of the real work of conceptual analysis consists in the preliminary search for new Is and Qs for analysis: ones which have not previously been considered worth thinking about or conceptualising.

Education needs perceptive thinkers in the background who are willing to question well worn stereotypes and to think about doing things slightly differently. Their reflections will begin by focusing on known problems and awkwardnesses in teaching certain items I or qualities Q in the classroom. Perhaps these difficulties, which have been felt by many experienced teachers, are trying to tell us something: namely that I is not as good an item as  $I^*$  (a variant item) would be, that Q is not as good a quality as  $Q^*$  (a variant quality) would be. There is, we know, a great deal of verbal

inaccuracy in most of the terms we commonly employ in education. They are capable of a considerable range of interpretations and it matters a great deal whether schools are interpreting them well or interpreting them badly. Being able to focus onto the true meaning of words is therefore a very valuable accomplishment in all teaching, not just in curriculum research. Teaching this verbal focusing produces a kind of mental sharpness which tends to spark off a similar sharpness in the pupils. It is quite close to the essence of 'education' (Hirst, & Peters, 1970).

## **METHODOLOGY**

### **Identifying the Problem**

In this research the author and his colleague identified the concept of 'Application Readiness in Maths' (ARM). Consider the following simple thought experiment: suppose you ask a question of the following kind (to most 7-8 year olds in most countries): "What number, when you subtract from 7 it, leaves 3?" What answer will you get from the children?

The answer you often get is '4'. The children hear the number 'seven' and the operation 'subtract' and the number 'three', so they subtract 3 from 7!

This is a sign that they often try to avoid *thinking* when arithmetical questions are posed to them. It is a sign that early maths instruction is often conducted as a ritual, which is not associated (by the children) with any kind of meaning. This begins at home. Younger children can often count numbers up to ten (say) without being able to answer simple questions like "How old will you be at your next birthday?"

This ritualised, mechanical teaching of arithmetic is clearly bad, but one has to say that the terms of the curriculum, the forms of testing, and the norms of teaching are all conducive to it. In schools

with good mathematical reputations the teachers are careful to get the pupils to think about what they are doing. But even in such good schools it is not common to find pupils who feel any positive inclination to *apply* their simple arithmetic usefully to real life problems. They 'know' in the back of their minds that it can be applied to real-life problems, but they do not feel any strong desire to see what it will lead to. Sometimes textbooks are used which contain apparent applications of arithmetic, but these 'applications' invariably require almost no thought on the part of the pupil. Some of them are quite silly or pointless, and consequently when they are encountered the children may easily acquire a negative attitude to such questions. Some teachers feel quite strongly that mathematics is not a utilitarian subject, but a 'science of higher things'.

The children are apt to pick up these feelings and to 'switch off' when invitations to make bogus applications of arithmetic are put in front of them. In general most children appear to have no appetite for applying their maths in a meaningful way to real-world problems.

The author and his colleague had tested this hypothesis in twelve middle schools in the Norwich area of the UK some time ago.

## **RECORDING SESSION AND RESULTS**

Children aged 10-11 years were given copies of readable short narratives involving, and built around, identifiable attractive child characters. The narratives used were specially designed: they contained numerous *mistakes* of fact, of grammar, of acceptable behaviour and of the meaning of words, all of which were contained within utterances of the child characters in them.

The method of procedure was this. First two or more volunteers read the various paragraphs of the narrative out loud. Then the children were quizzed as a class about whether they understood it.

Finally they were told to read it again individually and to look for *mistakes* made by the child characters in the story. They were asked to write down any mistakes which they spotted.

The stories used typically contained about twelve clear, evident mistakes, of which three were mistakes of arithmetic. The results of this experiment were striking. The authors discovered that, at all the schools involved, a fairly high proportion of the non-mathematical mistakes were correctly spotted by the children. However the proportion of arithmetical mistakes spotted by the children was very low indeed. Typically one or more very bright child would spot one or more of the arithmetical mistakes, but virtually all the children routinely accepted mistaken arithmetical claims made by the child characters in the stories.

For example in one story the two children involved went fishing, but without success. They were unable to catch any fish. So they decided to buy six fish at the fishmonger's shop. When they got home they told their parents that they had caught four fish each. To try to convince their parents they showed them the six *kippers* they had bought at the shop. In this case many children spotted that the characters should not have lied to their parents. Nearly all the children knew that it was a mistake to buy 'kippers', because they were smoked fish and therefore their parents would know immediately that they were lying. The children were so interested in showing the researcher that they had spotted these mistakes that they almost all failed to notice that if they caught four fish each (as they claimed) they would have more than six fish in total.

Of course the researchers were only able to do this kind of experiment with a given class once. After their faulty answers to first story had been pointed out and evaluated, the children were naturally fully alerted to looking for arithmetic mistakes in new narratives of this kind and they did, of course, find them.

But the experiment showed that children, uncued to the risk of overlooking arithmetic mistakes, did in fact, on almost all occasions, overlook them. They were evidently quite averse to *applying* their simple arithmetic knowledge. Although the applications were easy and well within their capability, they did not make any effort, uncued, to do them.

This aversion, it was clear, was quite common among the 300 or so children tested during the research. Some of the schools were in middle class areas and others were in working class areas. It made little difference to the result: the children in both kinds of schools suffered from the same aversion. It deserves a name: 'application un-readiness'. The children, when faced with a problem which would benefit from an easy application of simple arithmetic, were not at all inclined to apply their arithmetic to it.

The opposite quality in children is 'application readiness'. A child who has this quality will look at a problem, eagerly check whether it can be solved using simple arithmetic, and then eagerly apply the necessary maths to it.

## **DEVELOPMENT**

### **Promoting Application Readiness**

It may be asked, how can Application Readiness be promoted in mathematics? One simple strategy based on the work described, is regularly to give children stories of the kind used in the research and ask them to spot mistakes of an arithmetic kind. A more systematic answer is to base the mathematics curriculum of the school on the premise that any topic T taught in the curriculum should regularly be involved in applications to simple situations S in the real world which the children see as *real and interesting* (Blair, 2002). It is important that the topic T when applied to S should result in an answer which, in some sense, 'makes a difference' in the sort of terms ordinary people apply to the real world. It is not

just a way to 'mathematicise' an ordinary situation. That will be of a dubious currency if the children are not already convinced that mathematics is a grand subject. Showing them that T can be used in all kinds of real situations S to obtain answers which ordinary people recognise and appreciate is the name of the game: if, that is, you are interested in building up the application readiness of your pupils.

## CONCLUSION

Conceptual research has been a neglected element in the total body of regrettable, because it can lead to significant improvements in the quality of education. In the educational research which is undertaken in most countries. This is case considered conceptual analysis led to the idea of testing children for 'application un-readiness' in simple mathematics. The results of the experiment were clear cut: only a very few children in the sample made any effort to apply their mathematical knowledge when there was no explicit instruction prompting them to do this. The rest displayed unmistakable 'application un-readiness'. This is not a satisfactory state of affairs and it is one which mathematics teachers should address. They should regularly challenge their pupils to apply their simple mathematical knowledge to interesting situations: ones in which the mathematics gives results which are of interest, not just as 'mathematics', but from the point of view of the average person.

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