How Early is Too Early for Thinking Algebraically?

John Mason

University of Oxford & Open University

My answer to the title question is that it is never too early for sensitively directed generalisation and abstraction. Indeed in some sense it is impossible to be too early, although of course it is always too early for insensitive instruction. This claim is elaborated with examples. My approach follows Maslow (1971): I am interested in what is possible, happy that others research what is the current case.

A Taste of What is Possible

Marina Papic (2013) reports use of a wide range of tasks, some used for assessing what children can do with patterns: copying towers of coloured blocks with a repeating pattern and determining missing elements which are shielded from the child. With Joanne Mulligan (2007) she has developed a sequence of discernible phases or stages of emergent pattern recognition and use. While recognising that mathematics education research usually takes this direction, I myself am more interested in alerting teachers to possibilities, and letting them watch and listen to children responding to stimulating tasks, without trying to classify the complexity of those responses.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *Achievement* | *Examples* | | |
| *Repeating Patterns* | Copying and extending a repeating pattern  Simple and complex repeating patterns | model copy age 4.1 Papic (2013) | | |
| Generating their own repeating pattern | age 5 age 5.4 Papic (2013)  C:\Users\user\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\DSC00545.jpg Chen (2015) Notice the rising and falling aspect which has to be ignored. | | |
| Recognising missing elements in repeating patterns | 未命名 age 6  age 6  Each line of three boats should be the same. Notice the change in direction. Chen (2015) | | |
| Articulating and expressing generality about repeating patterns |  | Child T11: “See this is a pattern of ‘I’ for Isaac, three green across, three blue up and three yellow across … two times”.  Papic (2013) | |
| Even more sophisticated articulation when the camels were joined into a circle | | Child T11: Big purple, little purple, little yellow, big green. It’s three times.  Papic (2013) |

Bornstein and Stiles-Davis (1984) tested children aged 4 to 6 on discriminating between symmetric and asymmetric polygons. They were looking for a developmental sequence, but this was without children being encouraged previously to work at symmetry.

|  |  |  |
| --- | --- | --- |
| *Symmetry* | Creating patterns with reflective symmetry  using one axis of symmetry;  using two axes of symmetry |  |
| Recognising missing elements in symmetrical patterns |  |
| Articulating what is missing and justifying in symmetric patterns | Eg. “this one has to be the same as that one” extending to “to make it symmetrical” to “because they are the same distance from the line” |

Joan Moss and Ruth Beatty (2006 p449) have shown that promoting conjecturing, using the language of “I have a theory” with 9yr olds, the children quickly picked up the practice and integrated conjecturing, and presenting evidence for their conjectures into their functioning (educating their awareness). They soon moved from displaying instances of their ‘theories’ on a grid (as a point graph) to ‘inventing’ negative numbers so as to extend their graphs to the left of 0. Their pattern sequences extended to quadratic relationships as they continued to propose and negotiate multiple expressions of generality.

|  |  |  |
| --- | --- | --- |
| *Counting* | Predicting the number of elements required on a repeating pattern | age 9  Joan Moss & Ruth Beatty (2006) |

Maria Blanton and Jim Kaput (2011 p9) reinforce the observation that children’s development of algebraic thinking has traditionally been constricted by inappropriate assumptions about what is possible: “… the genesis of these ideas [functional analysis] appear[s] at grades earlier than typically expected”. Cai, Ng & Moyer (2011) report on how learners are supported in developing algebraic thinking in China and Singapore, suggesting that this accounts for superiority in algebra later as compared with educational systems where not only formal algebra, but expressing of generality and development of algebraic thinking are not introduced until high school. Cooper & Warren (2011 p197) summarise their own and other people’s research by saying that “results have … shown that students can generalise relationships between different materials within repeating patterns across many repeats”. They go on to suggest that the use of tables can help students generalise not only in the younger years, but later in school, for example when working with equivalent fractions.

My claim is stronger still: learners need to generalise in order to make sense of mathematics, in order to appreciate and comprehend topics they meet, and that this natural power to generalise can be strengthened by acknowledging and calling upon it at the earliest opportunities. Learners who have not been called upon to express generality are at a major disadvantage as they move through school. As Gattegno famously said (private communication 1978) “the real problem with teaching mathematics in school is what to do after age 12, when they have learned the entire [current] school curriculum” (or words to that effect).

Mason, Graham, Pimm & Gowar (1985) made a case for multiple roots of algebraic thinking, and routes into explicit algebraic thinking, and showed how this could be done, drawing on materials and ideas stretching back to Chinese manuscripts, Egyptian papyry and Babylonian tablets, as well as projects in the UK in the 1960s and 1970s.

Why What is Possible is No Surprise

Any child who can walk and talk has already exhibited massive use of natural powers, including generalising and abstracting. Indeed, Davydov (1990) and followers (Jean Schmittau 2004; Barbara Dougherty 2008 among others) see humans as working from the abstract to instantiation in the particular, rather than the other way round. One possible reason is that language is fundamentally general. It requires work with adjectives and adverbs and-or direct use of deictics and pronouns, with touching and pointing, in order to be specific and particular. Children then need to learn to perform the reverse process of seeing the particular as an instantiation of something more general. Expressing generality succinctly and precisely is afforded by the language of algebra. The power of succinct expressions lies in the manipulative possibilities.

No-one expects young children to internalise or memorise all two and three digit additions and subtractions, much less multiplications and divisions. Instead, children are expected to internalise procedures which are sequences of actions to achieve these tasks. Yet telling someone how to perform these involves complex action sequences with choices being made according to the particular numbers (see last section for ways to re-experience this for yourself). It is a plausible conjecture that Egyptian and Babylonian scribes did not attempt to express methods of solving problems in general because of the effort required in using cuneiform on moist tablets and the expense of preparing papyry. Much more sensibly, they show worked examples, with assertions such as “thus is it done” (Gillings 1972) to indicate the potential generality. The use of worked examples has become an integral component of teaching through the ages, despite its weaknesses (Chi and Bassok 1989; Renkl 2002).

Where kindergarten teachers, indeed teachers of all ages, make use of and develop children’s powers to imagine and to express what they are imagining, in gestures, diagrams, words, and eventually symbols, children are being prepared to think mathematically, to engage with explicit not just implicit algebraic reasoning. I know of at least one child who burst into speech only when he became frustrated that his parents were not correctly interpreting his pointing. Algebra as a language makes it possible to refer rather than point, to avoid ambiguity in the use of prepositions such as *this* and *that*, and to deal with many if not infinitely many cases all at once. This is truly powerful thinking. Indeed Gattegno (1984 p20) proposed that a lesson is mathematical only when it is ‘shot through with infinity’.

Caleb Gattegno (1975) also suggested that “I made my brain” and that that is what every child who can walk and talk has managed to achieve. I think he meant that the brain develops not simply through experience of the material world, but as a result of processing that experience; that learning involves ‘educating awareness’ which means accumulating actions that can be enacted with a minimum of attention so that attention is available to provide overall direction (cf. Jerome Bruner’s notion that scaffolding involves the teacher upholding attention foci when the learner’s attention is fully absorbed by some detail: Bruner 1996)

The only real constraint on learners is their own. But this is influenced by their milieu: teachers, parents, institutions. Carol Dweck (2000) has provided massive evidence that children’s discourse, often picked up from adults around them, can be altered so as to shift from a negative, psychologically blocking stance towards a positive, psychologically opening stance. It can be roughly summarised as helping children turn “I won’t” and “I can’t” into “I can try harder and differently” (Open University 1982).

Why the Possible is Not Always Actualised

Teaching is a caring profession which depends on the relationships between teacher and learners, and teacher and mathematics in order to engender a productive disposition between learners and mathematics. Very often one or other of these ‘cares’ is stressed with the other disappearing into the background. Concentration on social organisation of groups of learners without also attending to the mathematics being discussed is an example of this.

Just as many textbook authors, educators and teachers see multiplication as repeated addition when in fact repeated addition is only an instance of multiplication, so textbook authors, educators, and teachers mistake the use of pattern generation and expressions of generality for algebraic thinking, when it is only an instance of generalisation. As I have said on many occasions “A lesson without the opportunity for learners to generalise mathematically, is NOT a mathematics lesson”. In the absence of other stimuli, children will generalise from a few boring lessons that “mathematics is not for me”. To learn to think mathematically, to appreciate and comprehend the mathematical enterprise involves generalisation and abstraction at every turn. The only reason children do not succeed is because their powers have been allowed to atrophy or to be left at the classroom door as the teacher tries to do the learning for the children.

Falling into habits

It is all too easy to fall into habits of how tasks are offered. For example, always offering the particular and expecting the general, rather than sometimes offering a partial generality, or a very general statement, so that learners can make use of and develop their power to specialise as well as generalise. For example, providing learners with the first few terms of a sequence and asking for successive terms makes two important mistakes. First, it habituates learners into reasoning forward, often inductively, and directs their attention away from looking at something structurally. Second, any sequence can be extended mathematically in any way you like. Before expressing a generality, it is essential to have some underlying general structure to express. Thus when learners are offered a sequence of pictures, whether geometrical or otherwise, there is no generality to express until there is a statement of how the picture sequence is formed and extended. Alternatively, a sequence with a repeating pattern can be presented to learners, with the proviso that the block that generates the sequence appears at least twice. Then (and only then, Mason 2014) can you be sure that the sequence can be extended uniquely.

Sensitively Promoting Generalisation and Abstraction

The notion of sensitivity is being emphasised because it is all too easy to try to push children, telling them things that they are not likely to be able to relate to their own experience. Of course there is nothing wrong in telling people things. The mistake is to assume that they have internalised what you have said along with your way of perceiving. Indeed, it is a mistake even to assume that they have made appropriate sense of what you have told them. Teaching by listening turns out to be far more effective. Although it lies behind various reform movements, trying to engineer other people’s teaching to match some imagined ideal proves to be ineffective (as the vast education experiment of the last 3000 years amply demonstrates). Instead of asking a question and then waiting for an answer, judging its appropriateness against the thought which prompted the question, teaching by listening involves putting learners in situations where they naturally ask questions (Davis 1996; Meyer 2013; Love & Mason 1992).

Recognising that children have already demonstrated and used astounding natural powers just to be able to walk and talk, and drawing upon, invoking and evoking these could be a central feature of teaching. That this has not happened is for me a sign of failure for my generation of mathematics educators and teacher supporters.

The *transposition didactique*, recognised and labelled by Yves Chevellard (1985) captures the shift from an expert becoming aware of something, and converting that awareness into a sequence of actions for learners to carry out. What almost always happens is that expert awareness (expert experience) is converted or transposed into training in behaviour: the instructions the expert gives in order to try to reproduce their experience in and for the learner. It takes a great deal of care for both the learner and the mathematics, to propose tasks that open up possibilities for learners rather than closing them down.

Multiple Expressions for the Same Thing

Algebraic manipulation ought, in my view to be a trivial matter. It can arise perfectly naturally when several learners each express the same generality, but differently (as usually happens when generalising picture sequences, but also in other situations). If several different looking expressions appear, it is natural to assume that there is some way to get from one to the other without using the original source: in other words, by manipulation of the expressions themselves. Having started in this vein with secondary students, drawing on various previous projects in the UK, we at the Open University soon realised that it was available to primary children (Mason 1990) as have many others. Those who have run into difficulty have often not drawn upon children’s powers appropriately.

Worked Examples & Tracking Arithmetic

Seeing someone work through an example using a particular technique can be very instructive especially if the learner then tries a similar example for themselves. But I suggest that it is only effective when the learner has some sense of what is particular and what is general; what are parameters in the examples, and what is structural. Furthermore, it really helps if the learner develops an inner incantation or patter which guides their actions, for the issue is not what to do next, but how you know what to do next. This has been verified by researchers looking at what is effective about worked examples (eg. Chi & Bassok 1989). Having an appreciation and comprehension of the procedure and why it works is also a contributing factor, because training behaviour (memorising a procedure step by step) is inflexible and by itself, instrumental (Skemp 1976). Trained behaviour is of limited use without educated awareness, which means developing a repertoire of actions that can then come-to-mind (actually, come-to-action along with associations coming to intellect and positive disposition coming to emotion).

Tracking arithmetic is one way to move quickly from specific examples to recognisably algebraic symbols (Mason, Graham & Johnston-Wilder 2005 p21; Mason, Drury & Bills 2007). You use a particular number (as in Think Of A Number games) but refuse to permit that number to be absorbed into any calculation. You can then track its route through the various steps, replace it with a cloud standing for some as-yet-unknown or unspecified number, and then eventually move to using a symbol.

In a similar manner, if you can check whether an answer is correct, you can track that number, then replace it by a cloud or symbol to produce algebraic constraints (equations or inequalities) which you can then set about resolving. Mary Boole pointed out that what is needed is to ‘acknowledge the fact of [y]our ignorance’, denote that by a symbol, and then express what you do know using that symbol (Tahta 1972). As Davydov and followers have amply demonstrated, using letters for as-yet-unspecified quantities is no barrier when handled sensitively and appropriately. It has long been recognised that expressions often start as verbal phrases or clauses, migrating to succinct short forms, and then to single letters when learners are confident in expressing generality. Indeed Küchemann (1981) delineated six different modes. If as-yet-unspecifieds, numbers in the mind of someone not present are symbolised by, with and for young children, there might be no need for long transitions into algebraic manipulation.

For learners who have not yet been stimulated to think generally rather than always in particular, it may not even occur to them that the context in which a mathematical task appears can be altered. Getting learners to make alterations for themselves contributes to their sense of power and control over a task-type, rather than feeling at the mercy of what ever might appear on an examination.

Enriching an Example Space

Pólya (1962) suggested that reflecting back on what had happened during work on a problem is one of four phases of effective mathematical thinking. But as Jim Wilson (personal communication 1984) pointed out, “it's a phase more honoured in the breach”. Although it is always tempting to rush on the next task in a glow of success, making use of released energy of satisfaction to reflect and form images of future choices can be a much more worthwhile investment of time and energy. There are numerous pedagogic strategies that can be used to bring back to mind effective actions so that they are more likely to come-to-action again in the future when needed. Asking yourself

What was effective? What is it about the task that made that particular approach effective?

What other similar tasks could be resolved using the same method?

What other choices of parameters would give the same answer?

What is the set of possible answers to tasks like this? What would make a task similar to this one?

Are there any parameter values that will not work, or conditions on such parameters?

This last is effectively opening up the question space (Sangwin 2006) which in some sense corresponds to the example space (Watson and Mason 2002) being explored. In addition to a range of central and peripheral examples of some concept or procedure, the example space includes construction techniques for altering an example, and when appropriate, a sense of what boundary examples there might be. The question space is structured around the various constraints that make questions do-able.

Reasoning About Numbers

Reflecting on the operations of arithmetic, and expressing these, produces the axioms of algebra, and justifies the claim appearing in most textbooks since the 15th century, that algebra is arithmetic with letters. Generalised arithmetic is one of the several roots of, and routes into, algebra.

Reasoning Without Numbers

Children struggling with arithmetic, for what ever reason, can often display superior powers of reasoning when the objects are not numbers. For example, reasoning about strategy in Secret Places (Mason, Oliveira & Boavida 2012) can be done with and by young children. Reasoning about magic squares without actually having a particular one to hand is also possible though careful introduction is needed so that children appreciate what the colouring means (Mason *et al* 2012)

Parallel Tasks for Adults

Have someone read out a list of some five or six three and four digit. The first task is to write them down backwards: this means that the units digit is on left, then the tens digit and the others proceeding to the right, with the numbers underneath each other. The task is now to add up the numbers so that the final number, read from right to left is the correct answer.

Because the usual format is altered, internalised actions are inappropriate and have to be re-thought and re-formed. The result is that it is possible to experience uncertainty, to notice attention movements which might parallel the efforts of a child learning to do column addition. If this task doesn’t succeed, try writing the dictated numbers with the digits in columns!

Try to construct a spread-sheet to perform long division, each digit in a cell. Even three column addition or subtraction can be a challenge. Yet this is what young children are expected to internalise, as well as to appreciate and comprehend what they are doing and why it works. The restrictions imposed by the minimal tools available in a spread-sheet highlight the complexity of instructing a machine to perform a complex task.

|  |  |
| --- | --- |
| Is there enough information to decide the colour of every peg if the resulting pattern is to be symmetric about both lines? |  |

Catching how you use your attention can give you a taste of what it might be like for children doing similar tasks, including the amount of effort required. Of course using an actual pegboard is easier for children, but an adult can do it without.

|  |  |
| --- | --- |
| Use the first diagram to explain why the ‘up and down’ sum 1 + 2 + 3 + 4 + 5 + 4 + 3 + 2 + 1 = 25 and generalise. Use the second and third diagrams to provide an alternative way of seeing (Mason 2008). Extend or modify the diagrams to display other sums, such as the sum of the numbers leaving a remainder of one when divided by 3. |  |

Developing flexibility in interpreting diagrams can contribute to flexibility when creating diagrams, and in seeing algebraic expressions in different ways. Expressing generality can be tougher than first appears, as in this next task, taken from Mason (1988 p29).

|  |  |  |
| --- | --- | --- |
| If you draw a single square, then develop a sequence of pictures by adding, at each stage, all the squares touching exactly one vertex of one previous square, you get a sequence of pictures. How many squares will appear in the *n*th picture? | Pictures 2, 3 and 4 | Double click above to run animation. |

Conclusions

It is well known that assumptions turn into expectations, and that expectations have a significant influence on behaviour: your own expectations are framed by the expectations of those around you, subtly and overtly expressed. The abiding question is how to the assumptions and expectations of parents and institutions can be opened up to the enormous powers that children have displayed when they learn to walk and talk, and to call upon these powers when being with children.

Algebra, or rather the use of natural powers which, when expressed in words and symbols is recognisable as algebra, is called upon from birth of not before. To learn arithmetic, that is, to gain facility with numbers, is to think algebraically, even if not explicitly. There is a long tradition of invoking and evoking children to make use of and to develop their powers, but this tradition is constantly being submerged in the mistaken desire that children perform arithmetic. Performance follows and is part of appreciating and comprehending, but appreciating and comprehending requires more than simple training of behaviour. Only behaviour is trainable; only awareness is educable; and these depend on the fact that only emotion is harnessable.

*References*

Blanton, M. & Kaput, J. (2011). Functional Thinking as a Route Into Algebra in the Elementary Grades. In J. Cai & E. Knuth (Eds.). *Early Algebraization: a global dialogue from multiple perspectives*. Advances in Mathematics Education. Berlin: Springer. p5-23.

Bornstein, M. & Stiles-Davis, J. (1984). Discrimination and Memory for Symmetry in Young Children. *Developmental Psychology* 20(4) p637-649.

Bruner, J. (1996). *The Culture of Education*. Cambridge: Harvard University Press.

Cai, J. Ng S. F. & Moyer, J. (2011). Developing Students’ Algebraic Thinking in Earleier Grades: lessons from China and Singapore. In J. Cai & E. Knuth (Eds.). *Early Algebraization: a global dialogue from multiple perspectives*. Advances in Mathematics Education. Berlin: Springer. p25-41.

Chen Ch-S. (2015). Developing Young Children’s Invention and Identification of Mathematical Patterns. Poster presented at PME39, Hobart.

Chevallard, Y. (1985). *La Transposition Didactique*. Grenoble: La Pensée Sauvage.

Chi, M. & Bassok, M. (1989). Learning from examples via self-explanation. In L. Resnick (Ed.) Knowing, learning and instruction: essays in honour of Robert Glaser. Hillsdale, NJ, USA: Erlbaum.

Chi, M. & Bassok, M. (1989). Learning from examples via self-explanation. In L. Resnick (Ed.) *Knowing, learning and instruction: essays in honour of Robert Glaser*. Hillsdale, NJ, USA: Erlbaum.

Cooper, T. & Warren, E. (2011). Year 2 to Year 6 Students’ Ability to Generalise: models, representations and theory for teaching and learning. In J. Cai & E. Knuth (Eds.). *Early Algebraization: a global dialogue from multiple perspectives*. Advances in Mathematics Education. Berlin: Springer. P187-214.

Davis, B. (1996). *Teaching Mathematics: towards a sound alternative.* New York: Ablex.

Davydov, D. (1990). *Types of Generalisation in Instruction*. Soviet Studies in Mathematics Education Vol 2, NCTM, Reston.

Dougherty, B. (2008). *Algebra in the Early Grades*. Mahwah: Lawrence Erlbaum.

Dweck, C. (2000). *Self-theories: their role in motivation, personality and development*. Philadelphia: Psychology Press.

Gattegno C. (1975). *The Mind Teaches The Brain*. New York: Educational Solutions.

Gattegno, C. (1984). On Infinity. *Mathematics Teaching* 107 p19-20.

Gillings, R. (1982). *Mathematics in the Time of the Pharoahs*. New York: Dover.

Golomb, Claire. (1992). *The Childs Creation of a Pictorial World.* Berkeley: University of California Press.

Hewitt, D. (1998). Approaching Arithmetic Algebraically. *Mathematics Teaching*, *163*, 19–29.

Küchemann, D. (1981). Algebra. In K. Hart (Ed.), *Children's Understanding of Mathematics: 11-16*, London: John Murray, p102-119.

Maslow, A. (1971). *The Farther Reaches of Human Nature*. New York: Viking Press.

Mason, J. (1988). *Expressing Generality*. Project Update. Milton Keynes: Open University.

Mason, J. (1990). *Algebra*. Supporting Primary Mathematics PM649. Milton Keynes: Open University

Mason, J. (1992). *Teaching Mathematics: Action and Awareness*. Open University, Milton Keynes.

Mason, J. (2008). Up and Down Sums, or Why are we Doing This Miss?: inner and outer aspects of tasks. *Studies in Algebraic Thinking 1*. PMTheta.com/studies.html (accessed Sept 2015).

Mason, J. (2014). Uniqueness of Patterns Generated by Repetition. *Mathematical Gazette*. 98 (541) p1-7.

Mason, J. Drury, H. & Bills, E. (2007). Explorations in the Zone of Proximal Awareness. In J. Watson & K. Beswick (Eds.) Mathematics: Essential Research, Essential Practice: Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia. Adelaide: MERGA Vol 1 p42-58.

Mason, J. Graham, A. & Johnston-Wilder, S. (2005). Developing Thinking in Algebra. London: Sage.

Mason, J. Oliveira, H. & Boavida, A. M. (2012). Reasoning Reasonably in Mathematics. Quadrante, XXI (2) p165-195.

Meyer, D. (2013). The Three Acts Of A Mathematical Story. <http://blog.mrmeyer.com/2011/the-three-acts-of-a-mathematical-story/>. (Accessed Sept 2015).

Moss, J. & Beatty, R. (2006). Knowledge building in mathematics: Supporting collaborative learning in pattern problems. *Computer-Supported Collaborative Learning* (2006) 1: 441–465.

Open University (1982). *EM235 Developing Mathematical Thinking* (distance taught course 1982-1988). Milton Keynes: Open University.

|  |
| --- |
| Papic, M. (2013). Improving Numeracy Outcomes for Young Australian Indigenous Children through the Patterns and Early Algebra Preschool (PEAP) Professional Development (PD) Program. In L. English & J. Mulligan (Eds.). *Reconceptualizing Early Mathematics Learning*. NY: Springer. p253-281. |

Papic, M., & Mulligan, J. T. (2007). The growth of early mathematical patterning: An intervention study. In J. Watson, & K. Beswick (Eds.), *Mathematics: essential research, essential practice*. (Proceedings of the 30th annual conference of the Mathematics Education Research Group of Australasia, Hobart), Vol. 2, pp. 591-600. Adelaide: MERGA.

Pólya, G. (1962) *Mathematical discovery: On understanding, learning, and teaching problem solving* (combined edition). New York: Wiley.

Renkl, A. (2002) Worked-out examples: Instructional explanations support learning by self-explanations. *Learning and Instruction,* *12*, 529–556.

Sangwin, C. (2006). Mathematical Question Spaces. In M. Danson (Ed.). Proceedings of 10th CAA International Computer Assisted Assessment Conference. Loughborough: Lougborough University, p377-386.

Schmittau, J. (2004). Vygotskian theory and mathematics education: resolving the conceptual-procedural dichotomy. *European Journal of Psychology of Education.*  19(1) p19-43.

Skemp , R. (1976). Relational and Instrumental Understanding. *Mathematics Teaching*. 77 p20-26.

Tahta, D. (1972). *A Boolean Anthology: selected writings of Mary Boole on mathematics education*. Derby: Association of Teachers of Mathematics.

Watson, A. & Mason, J. (2002). Extending Example Spaces As A Learning/Teaching Strategy In Mathematics. in A. Cockburn & E. Nardi (Eds.). Proceedings of PME 26, University of East Anglia. Vol 4 p377-385.