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"I get better and better all the time": Impact of resources on pupil and teacher confidence

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We report on the findings from the first year of a two-year study exploring how teachers and children experience and use Pearson Abacus resources, including perceptions of impact on (teacher and children's) confidence. Abacus was designed to foster a confident learning environment for children to master mathematical concepts within the 2014 English National Curriculum. Data were collected from nine schools: from teachers and pupils in nine KS1 classes and nine KS2 classes, and from the schools' Maths Coordinators. Teachers considered Abacus impacted positively on both their own and children's confidence to work mathematically. However, some teacher confidence may not be well-founded, and the learning potential of the resources is not being harnessed, if they do not use the support provided to enhance their subject (and subject pedagogical) knowledge for teaching a richly conceptual network.

Keywords: Abacus; confidence; self-efficacy; resources; primary.

Introduction

Multiple studies have shown that young people often lack confidence in their mathematics functioning – and further that their confidence often declines with age (e.g. Hannula, 2012). Related research has often taken place within a secondary context. This paper is based on a 2016-18 study exploring the impact that the use of Pearson Abacus resources has on pupil learning/experience in a sample of English primary schools. In England, primary teachers typically teach one class across the curriculum, so are not usually mathematics specialists. Teacher confidence in teaching mathematics is therefore also often an issue (Ofsted, 2012). We therefore asked, 'What impact do the Abacus mathematics resources have on teacher and pupil confidence?'

Background

The Resources

Abacus is a set of English primary (usually age 5-11, years 1 to 6) mathematics materials, developed in line with Oates' (2014, p. 4) characterisation of effective resources. The resources are primarily accessed electronically on ActiveLearn, a digital learning space that includes a toolkit for teachers and pupil resources. This is complemented by a range of text books and progression workbooks for pupils.

As described on the website (Pearson, n.d.), Abacus has been produced to "inspire confidence and a love of maths" as well as to "help your school develop confidence in using Abacus". Based on the 2014 English National Curriculum (DfE, 2014), the Abacus objectives reflect that programme of study, mirroring a government aspiration for higher attainment in mathematics given perceived mediocre performance in international comparisons. The pupil resources aim to engage and inspire children to learn mathematics, creating a confidence-supportive environment including through support for teachers in their understanding and use of the resources.

For example, the online teacher toolkit includes a planning tool (at a variety of scales), the 'teaching tools' - whole class and interactive activities - and a variety of assessment and tracking tools and tests, together with reporting tools. There are adaptable daily, weekly or termly lesson plans that include substantial teacher support, pointing to likely misconceptions and ways to expose and address those, prerequisite knowledge, learning design and opportunities within the resources, key probing questions and valuable responses to those. These provide for varying levels of teacher experience and confidence. Examples of teaching tools include the bar modeller, '5-minute fillers', 'QuickMaths', 'Fluency Fitness', 'mastery checkpoints' and homework sheets. Accompanying these are interactive digital versions of many related physical resources, for class projection.

The literature shows resources convey specific messages about mathematics and its organisation (Raman, 2004), as well as influencing what and how mathematics should be taught (Love & Pimm, 1996), though Chevallard (2003) shows teachers often ignore suggested approaches or elements unless those are already present in their 'personal relationship' with mathematics.

Confidence and related characteristics

Affect is a key variable in students' learning (Hannula, 2012). While academic literature uses a broad range of theoretical constructs to explore self-confidence, the Oxford English Dictionary (2017) defines it as "a feeling of trust in one's abilities, qualities and judgement". Some theorists suggest that students' confidence in their own abilities is a better predictor of achievement than their current attainment (Pajares & Miller, 1994). For the purposes of this study two key constructs, academic self-concept and academic self-efficacy, will be taken as being key to understanding pupils' confidence in mathematics. The two constructs are grounded in social cognitive theory which suggests that students' potential is dependent on the relationship between their own behaviours, personal factors (e.g., thoughts, beliefs), and environmental conditions, pointing to the centrality of classroom learning environment and ethos.

Bong and Skaalvik (2003, p. 10) define academic ***self-concept*** as "knowledge and perceptions about oneself in achievement situations". This includes an individual's broad appraisal of their own competence, as perceived over an extended period of time, and is informed by frames of reference that are likely to be grounded in social comparison. In contrast, academic ***self-efficacy*** is embedded in specific contexts, even in specific tasks. It is less contingent on "what skills and abilities individuals possess", instead focusing on what students believe they can achieve with those skills and abilities. These beliefs are likely to change over time and are linked to students' previous experiences of undertaking a given task. Bong and Skaalvik (2003) show that that self-efficacy and self-concept are distinct, if related, concepts with self-efficacy feeding into students' more holistic and stable sense of self-concept.

Students' levels of ***motivation***, and of cognitive, affective and behavioural ***engagement*** are also strongly interrelated with feelings of self-efficacy, self-concept and ultimately achievement (Bandura, 2001). Motivation can be understood as either being extrinsic (based on external social factors) or intrinsic, where students are engaged in an activity chosen or pursued for its own sake. Intrinsic motivation is key to achieving meaningful learning (Schweinle, Meyer & Turner, 2006). Motivation is influenced by the nature of the task the students are set. In addition to their expectations of success, the personal value that they place on the outcomes is also important (Eccles & Wigfield, 2000). Pedagogy should therefore develop these characteristics. The development of a growth mindset, explained for Abacus teachers by Pearson (n.d.) is also important for intrinsic motivation. In contrast, there is evidence showing a 'fixed mind set' is often pervasive in English mathematics education (e.g. Ofsted, 2012).

Where digital technologies are used, they have the potential to increase mathematics students' intrinsic motivation (Calder, 2011), potentially providing another dimension to classroom learning. Mathematics-focused digital learning practices may also help primary-school-age students significantly raise their mathematics related self-efficacy (Hung et al., 2014). For example, multiple representations such as those easily afforded digitally are key to children developing deep conceptual understanding (Bryant, Nunes & Watson, 2009).

The Study

We report from the first, qualitative, year of Pearson-funded research which asked how teachers and children experience and use the Abacus resources; ethical approval and use of external researchers addressed issues of funding-related threats to validity of outcomes. We base our discussion on findings from 3 sub-questions: 1) To what extent do the resources as used engage children in mathematics? 2) Which aspects of the resources impact on their confidence? and 3) To what extent do the resources support teachers' confidence? Data were collected as shown in Table 1 and then analysed by sub- question in N-Vivo and axially coded. Coding was validated by at least one other researcher, and final interpretations and reports offered to field researchers and teacher participants for further validation.

Table 1: Summary of data collection

Fieldwork	Methods Used	Data
Autumn 2016	Standardised baseline assessment of individual and class-level characteristics. Telephone interviews: 18 class teachers + 7 (other) maths coordinators (MCs)	18 class assessment reports 25 interview (i/v) transcripts
Spring 2017 visit	Lesson observations. Class teacher (plus trainee teacher) interviews. Pupil focus groups	19 i/v transcripts Plans and observation notes for 18 lessons 18 focus group transcripts
Summer 2017	Teacher and MC interviews	25 i/v transcripts

Twelve participant schools were selected based on a variety of characteristics (type, size and inspection categories) as well as of socio-economic and geographical contexts. Additionally, schools had also bought different combinations of print or digital Abacus resources. Nine became established participants in the study; three others withdrew during early autumn 2016 due to local changes. There is no claim to generalisability from the study: rather, it aims to provide an in-depth understanding of a range of use and impact of the Abacus resources.

Findings

This first year highlighted that at least 15 of 25 teachers perceived challenges with pupil confidence in their classrooms, with many referring to fixed mind-sets:

> It's …not being scared of numbers, just having their confidence, I mean some children are really under confident when it comes to things like maths, or they don't understand it so they just shut off. (Year 5 teacher 9, Autumn interview)
>
> They're too quick to jump, because maths is a right or wrong. If they're not sure, they…think it's wrong and don't attempt it. (Year 5 teacher 4, Spring interview)

By the summer interviews, however, at least 14 of 18 class teachers reported confidence in mathematics had grown amongst the pupils. Below, we discuss the reasons given for this.

Children's engagement with the resources

Engagement is clearly a prerequisite for classroom learning, so was an aspect of initial probing in teacher interviews. Where, additionally, a classroom offers an environment fostering deep, conceptual learning then well-founded mathematics confidence can develop. Among physical resources, Abacus textbooks were the most used resource for year 5s whereas the workbooks were most popular for year 1s. Teachers widely endorsed these resources as engaging for children, pointing in particular to the colours, usability, characters and range and variety of activities.

While physical resources were highly praised in the interviews, teachers particularly noted the interactive whiteboard (IWB) front-of-class activities as a means of sustaining children's engagement in learning. All 18 class teachers pointed to at least one part of the IWB activities that children found particularly useful or engaging. Praise was primarily centred on the opportunity afforded for teachers to place learning in a different context:

> …other than me writing on the board constantly then just following along the same old sums and whatever. It just puts it in a different context and makes it a little bit more fun so it engages them a bit more I think (Year 5 teacher 1, Autumn interview)
>
> Most units I would use the interactive whiteboard activities because they are very engaging and most of the time they are super. They love the things like the number line with the dinosaurs, when they roar when it moves up and down (Year 1 teacher 4, Autumn interview)

These examples support the wider research that discusses the importance of authentic representations (e.g. Bryant et al., 2009). Dinosaurs moving up and down may not be a realistic representation of a number line, this particular activity exemplifies an authentic model and academic task that engages children in learning. Similarly, a Year 1 lesson observation illustrates the use of a digital clock tool activity. This task and activity can be applied to a real-life context, immediately underpinning the children's learning in a context they are already familiar with:

> The clock tool worked extremely well in this lesson – it is such a flexible resource that teacher could adapt. It was particularly powerful to be able to show digital alongside analogue e.g. when counting in tens: the count was visible on the digital clock; 1/2 past – the digital clock reinforced idea that half an hour is 30 mins. Children were very motivated by being able to click the button to forward the clock – the large visual image was very helpful (Year 1 lesson observation notes)

Teachers felt that context and relatability were important and therefore, the more practical they made the subject, the better. The practical activities offered by Abacus proved to be hugely popular with the pupils. Teachers claimed that involving pupils with physical, as well as digital, resources increased pupil engagement and enjoyment in lessons. Practical activities were particularly valued as they were seen to be very effective in supporting links underpinning deep conceptual understanding:

> I know it's very simple but they really love it because they can see that a number is being represented in front of them physically and I think for a lot of them it took a while. If I was to write a number on the board they knew which number it was but they didn't really fully understand what the number represented. But when I put, if it be blocks or Legos or even just a dice, they could see it in front of them and they understood then right nine means nine dots or nine or six dots or so on and so on. (Year 1 teacher 2, Summer interview)

Evidence from teacher interviews is consistent with wider research (Bryant et al., 2009) that suggests as children become more actively involved in their learning, in a variety of ways, there is an impact on engagement, motivation and maths related self-efficacy. The collection of learning resources provided in the Abacus scheme allows teachers to create an engaging and motivational learning environment that cater for a variety of learning needs. At least 14 of the 18 teachers reported that, as a result, a range of their pupils built and developed their confidence in working mathematically.

Abacus and children's confidence

Many teachers (at least ten) noted that Abacus' spiral structure and the repetition of focus over time benefited the development of children's confidence over the school year:

> I think the scheme does help in that way because of the way it's sort of cyclical revisiting things so if they didn't get it the first time you come to it another time and it's presented in a slightly different way. And they think 'oh actually I have seen this before and I think I can do this'… a lot of them are sort of emerging as more confident mathematicians. (Year 5 teacher 4, Summer interview)

> The way it goes back to each area: I think that's good for their confidence because sometimes, even after doing, say, a topic for a week, some of them might not get it or they might not be confident in the fact that they've got it. And the fact that it generally goes back to the same sort of topics over a period of weeks...does wonders for their confidence, because then they're able to keep practising. (Year 5 teacher 6, Summer interview)

Furthermore, teachers also suggested that the scaffolded progression helped pupils to visualise their own progression and achievement:

> And it does develop. They get quicker, they get more confident because the first one's easy, and then they can build it up to the harder ones towards the end. (Year 1 teacher 3, summer interview)

> I get better and better all the time. (Year 1 pupil, Spring focus group)

The differentiated and progressive approach to the activities were also mentioned as an effective means of impacting pupils' confidence:

> a lot of the children enjoy doing … the support work first before they move onto the core because usually it's the support page in the textbook gives them step by step instructions about how to solve it, whereas the core page will literally just say, here's a problem, get on with it. So usually if there's an issue with confidence, I suggest to the children, well you can do the support work first. But then you need to get onto the core...and I think that does help build their confidence (Year 5 teacher 9, Summer interview)

Finally, the ActiveLearn Games were perceived to change the way that pupils approached learning and had a measurable impact on their confidence: 'I think the online games have helped developed their confidence.' (Maths coordinator 4, Summer interview) This evidence reinforces the notion that engagement is a prerequisite to building confidence. One pupil stated: 'The ActiveLearn, it's really fun because you do the sums and the maths but you get to do a game as well, so it's fun.' (Year 5 pupil, spring focus group). At least three teachers went further, pointing to specific children who had begun the year with significant mathematics anxiety, but had progressed to being keen to the point of asking for extra mathematics tasks or games.

Teacher confidence

The Williams Review (2008) is clear about the enormous impact the teacher has on creating appropriate and confident learning environments and supporting valued learning outcomes in mathematics, even if mediated by appropriate and motivational resources. We therefore included questions about teacher knowledge, skills and affect in our interviews. A consistent theme that emerged was a recognition of the responsibility of teachers to effectively understand and implement the resources in order to best impact students, but also stories of teachers *coming to learn* how to best use Abacus. As one teacher explained:

> It is difficult because the best teacher in the world can make the worst resources look good and the worst teacher in the world can make the best resources look bad. It is how the teacher uses and delivers them that affects the motivation. (Maths coordinator 4, Autumn interview)

A positive example of this was teachers' productive use of pair work, as discussed by at least 8 teachers in interviews:

> Sometimes I'd get them to pair up because some of them are very shy. And I paired them up with somebody who was a bit more confident, a bit louder and I got them to maybe do an activity or a game together to do with what we were learning. And I found that it made them a bit more confident to speak but also more confident with numbers. (Year 1 teacher 2, Summer interview)

Teachers were also clear that pupil confidence is directly influenced by teacher confidence. Only two of the 25 teachers interviewed came from a mathematics specialist background, with many of the others (at least fifteen) describing how the Abacus resources had improved their own confidence in teaching mathematics. Of the Year 1 teachers, for example, 8 of 9 had only studied mathematics to age 16, with some even stating that they were 'maths-shy' in general. That the Abacus resources can be instrumental in shifting that confidence, then, including in the early years of teaching, is an important finding:

> I had …a student teacher, she's in Year 1 of her teaching degree and even she said to me that the session plans for Abacus are so helpful for her because they were so thorough and she could, she could take that lesson plan, read it over, and feel completely secure in delivering that to the class, which, for a Year 1 student, is quite an impressive comment (Year 1 teacher 8, Summer interview)

One interview with a trainee teacher provides an affirming example of the support Abacus provides for teachers lacking in experience and confidence:

> I love teaching it, and I really love Abacus, it's just very helpful when you're starting off with no background experience in teaching maths….Especially you know when I started with Year 1 I had no experience with Year 1, I didn't know what sort of

> level they worked… It's a really good starting point. (Trainee teacher 6, Spring interview)

Every teacher interviewed also praised the flexibility of the planning resources, usually for supporting a wide variety of teacher background and expertise, so teachers can adjust them to meet their specific needs. Two maths coordinators talked about how teachers who feel supported by the resources, and so confident in delivering the content, will create a learning environment best suited to develop pupil confidence:

> It's given me an opportunity to feel confident in myself and to enjoy teaching it which in turn means that they will enjoy learning … it's given me the confidence to be able to kind of deliver that securely. (Year 1 teacher 6, Spring interview)

However, observations showed that while responses to Abacus resources were almost entirely positive, many teachers were still not fully using the resource supports to their full learning potential, sometimes because of lack of familiarity. Several classroom observations pointed to occasions when resource design had been under-utilised because the teacher had a misplaced confidence in the depth of their subject knowledge, so that they missed learning opportunities factored into e.g. choice of examples. If they did not then make full use of the lesson plan guidance, children did not fully benefit from design intentions. At least 12 teachers also pointed to lack of time for teachers to get to know the resources in depth. None of the sample schools had bought in Pearson resource-specific CPD, and only two had used a CPD video included in ActiveLearn, choosing instead to come to know the resources informally and sometimes collaboratively. This last was talked about as a positive option, but might limit the depth of understanding of the intentions of the materials.

Conclusion

It is clear that the sample teachers feel that the use of Abacus, to whatever extent, significantly impacts pupil confidence. They suggested Abacus tools motivate and engage children, and so support an environment where pupils can develop their learning and build their confidence. All, but particularly the majority who are non-mathematics specialists, claimed that different facets of Abacus also impact positively on their own confidence as teachers. What the observation and other data clearly point to, however, is the importance of appropriate teacher understanding and use of the resources. Many teachers stressed the importance of this during interviews, placing onus on teacher enactment rather than on the resources themselves. When teachers are confident and effective in harnessing the resources to teach content, this in turn has a positive impact on pupil confidence.

However, lesson observations suggest that some of the teacher confidence (and so sometimes, pupil confidence) is not well-founded, as some teachers do not yet possess the deep subject (and subject pedagogical) knowledge necessary to teach for a deep conceptual network of mathematical concepts without external support. Such support is available, for example, in the lesson plan teacher notes but teachers do not always recognise the benefit of using those, so don't harness them. Critically, most teachers are not engaging with paid-for or in-package CPD provision which would point them to the benefits for children's learning of using, and acting on, those notes. Only if less specialist teachers access appropriate CPD will they be able to build and support well-grounded pupil confidence in meaningful mathematical functioning.

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