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Learning by Questions (LbQ)

Outcomes from Uses in Schools in Northern Ireland

Working Paper

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Acknowledgements
The author would like to thank most sincerely the principals, key teachers and pupils who were involved in discussions and observations, who provided invaluable evidence for this working paper. Thanks are due also to members of the EN(ni) Innovation Forum who supported and offered constructvie comments on the outlien of this working report, and particularly to staff in Capita for their support (Lisa, Jennie and Glenn). Individuals and schools in this working paper have not been named, to conform to ethical needs placed on reports of this nature - this should in no way be seen as devaluing the commitment and contribution played by all involved.

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1. INTRODUCTION

This working paper provides a background context to the uses of a specific software resource, *Learning by Questions* (LbQ), piloted in 6 schools across Northern Ireland, from October 2017 to July 2018. There has been continued use in those schools since the end of the pilot. The LbQ resource has similarities with previous software resources used in schools in the 1990s, called *Integrated Learning Systems* (ILSs). This paper compares the contemporary LbQ resource with these previous ILS resources, highlighting some fundamental differences that the LbQ resource offers. Case vignettes from four schools provide evidence of outcomes arising in practice. It is clear that uses are affecting and shifting both teacher and pupil behaviours. Importantly, some of these behavioural shifts are not only positively affecting learning and teaching, but also teacher wellbeing. Implications are considered.

2. BACKGROUND

The evidence in this working paper was gathered during visits to four Northern Ireland (NI) schools. This evidence was gathered through discussions with teachers and principals, and from observations in classrooms. Discussions and observations focused on eight key questions:

- How long had the schools been using LbQ?
- Why were they interested in using it?
- How many teachers and classes had been involved?
- What changes in teacher behaviours had arisen?
- What changes in learner behaviours had arisen?
- How do the teachers see the future deployment of the resource?
- What issues, challenges or problems have been encountered?
- What successes or improvements have been identified?

3. LbQ in Context

Learning by Questions (LbQ) is described on the company website as "a classroom app filled with curriculum-aligned Question Sets and immediate feedback to super-charge learning" (LbQ, 2019). The website goes on to say that, "With hundreds of scaffolded Question Sets covering basic understanding through fluency, reasoning and problem solving leading to mastery, you can develop classes with mixed abilities and stretch every pupil" (LbQ, 2019). Certainly, this resource provides question banks that cover entire areas of the curriculum for specific age groups (in mathematics, literacy and science). The questions are grouped according to levels of difficulty and their applicability to real-life problems. The levels allow pupils to move from more general understanding, to reasoning, and finally to problem-solving. Given this outline description, it appears on the surface, therefore, that this resource may be similar to previous resources that were used in classrooms, such as *Integrated Learning Systems* (ILSs).

An ILS was a computer-based system that managed the delivery of curriculum materials to pupils so that pupils were presented with individual programmes of work over a number of weeks and months. Curriculum content comprised an extensive range of tutorial, practice and assessment modules for a substantial part of a pupil's curriculum, with coverage across a range of subjects and levels of ability. A pupil record system maintained information on every pupil and recorded pupils' levels of achievement. A management system linked and controlled the flow of data and, dependent on the specific system used in a school, might perform a range of functions. These were: an interpretation of pupil responses in relation to the current task; updating of pupil records; choice of pathway through the curriculum content; delivery of the appropriate sequence of learning modules; and provision of feedback to pupils and teachers (modified from Brown, 1997, and Wood, Underwood & Avis, 1999).

ILSs were commonly adopted by schools across the United Kingdom (UK) between 1994 and 1999, but started to disappear from use after about 3 years, and were rarely found in schools within about 5 years. The reasons for the demise of these systems were not researched widely, but there were issues and challenges facing schools and teachers when using them (including technological, deployment, and pupil and teacher interest issues). By contrast to ILSs, LbQ offers a resource that is different in a number of respects. These differences are summarised in Table 1.

Previous ILS	Current LbQ
The system chose the questions and tasks	The teacher chooses the questions and tasks
Results were difficult to see in real time	Results are entirely accessible in real-time
Teachers monitored after an ILS session	Teachers monitor during an LbQ session
Teachers picked up issues after an ILS session	Teachers pick up issues during an LbQ session
ILS sessions were not easily integrated with other previous and follow-on activities	LbQ sessions are integrated into previous and follow-on activities
The system determined the follow-on questions and sessions	The teacher determines the follow-on questions and sessions
Pupils worked individually	Pupils work independently but also in the class context

Table 1: Comparison of LbQ with earlier ILS resources

LbQ has been used in the four NI schools since October 2017, so the outcomes reported in this paper arise after a second year of use (about 15 months after the start of the pilot). The schools involved in gathering details for this paper were two primary, and two post-primary schools. All observed uses in the schools were in mathematics, but one teacher in one school talked about uses in literacy (primary).

4. CASE VIGNETTE 1

This primary school has a pupil intake population with a high level of free school meals (FSM) - 40%. It has been using LbQ since October 2017, piloted for one year, and continued since that time. The class teacher (also the mathematics co-ordinator) and the acting principal confirmed that the pattern of use of LbQ had changed since the end of the pilot, and the amount of use had been reduced, although its positive value was clearly recognised. During the pilot, the resource was used every day for a 1.5 hour lesson, while in the following year it was used perhaps for 3 sessions per week, and as a part of each lesson on those occasions.

The teacher said that when introducing LbQ, it took about a month for pupils to develop practice so that they could move into a routine that involved reading feedback, and working together. After a holiday break, it took about 2 lessons to get back into that same routine. It also took time to encourage pupils to talk about their work in ways that brought out 'how they did it', rather than 'this is the answer'.

The teacher reported that pupils who had more difficulty with working on paper, and with mathematics in general, were supported particularly by use of LbQ. For those pupils, their independence in working was seen to be enhanced; they could easily see how they had managed to work on something to get it right or wrong; they could work on their own, increasing their self-confidence. The teacher reported that, in this respect, the form of questions was crucial – pupils needed to answer the questions, rather than choosing from a list of multi-choice answers.

A P6 class (9 to 10 years of age) with 30 pupils had access to an interactive whiteboard (IWB), 30 tablets, and a teacher iPad. The class set of tablets was low cost but sturdy (Alcatel). The tablets were delivered with cases, but they found that if the case was used, then the camera could not be used. The LbQ app was loaded on the tablets, together with other apps such as *Accelerated Reading* and *Education City*. The 30 pupils were mixed ability in terms of their results in mathematics. This ranged from those who found mathematics difficult (there were 2 refugee children and 2 with special needs in mathematics in the class), as well as 7 pupils who were reported to be very good at mathematics, 6 who were good, 6 in the middle range, and 2 who found mathematics challenging. A classroom assistant aided the class.

The teacher found that she was able to manage the use of LbQ so that pupils could learn from each other. Pupils receive feedback when they get a question right as well as wrong, so pupils who did get right answers were also reassured of their success by this form of feedback. The teacher supported peer learning when using LbQ. During an observation, for example, one pupil showed nine other pupils on the IWB how to tackle a problem. The teacher afterwards provided another example. With this form of peer learning involved, generally, it was found that the IWB was used more by pupils than by the teacher.

The teacher found that pupils who were less confident with mathematics found ways to handle feedback when they got questions wrong, so they could self-direct how they responded to the feedback, and so their independence was enhanced.

The teacher was able to identify different groups of questions for different groups of pupils. Also, the teacher could pause the use of LbQ for one group, without it affecting the others. In this way, specific support could be tailored to, and provided for, a specific group of pupils. As the teacher said, this 'aids easy differentiation'.

The teacher uses LbQ in order to move pupils as much as possible onto reasoning and problem-solving question sets, as these can stretch pupils most. These questions rely more on real-life application, and, as the curriculum requires teachers to focus on subject content that pupils can then apply to their life situations, reasoning and problem-solving are important elements to introduce and cover. These questions also support those pupils who are seeking to achieve positive outcomes for grammar school intake through the transfer test.

The tablets had been used in a variety of ways, individually, with pairs, or with groups of pupils. When using them individually, the teacher could monitor and hear what the pupils were doing, and whether they were finding problems. If they did find a problem, the teacher asked another pupil who had done it already to come to the IWB and demonstrate to other pupils how to do it. The teacher found that using LbQ had meant that there had been more time for peer instruction. The teacher reported that the value in this was that the explanation came from a pupil perspective, and some pupils were found to understand this better. These forms of increased communication (teacher-pupil and pupil-pupil) were supporting learning, but also the outcomes of LbQ answers gave confidence to those who managed to tackle the tasks and find the answers. This provided for more opportunity for discussion of how to find the answers, rather than the focus being on getting the right answer. So pupils talked about how they got the answer, and identified problems they faced.

The teacher found it was possible to listen more to pupils talking about their work, and identifying their misunderstandings. LbQ was recognised, therefore, as a vehicle to support more listening, offering more independence, and enhancing engagement and attention. LbQ was consequently considered by the teacher as a delivery platform, so the teacher was released to undertake more monitoring. Through this shift, LbQ is supporting the learning of mathematics; the teacher is more concerned with 'understanding'. The pattern of what might be called 'teaching behaviour using LbQ' is shown in Figure 1.

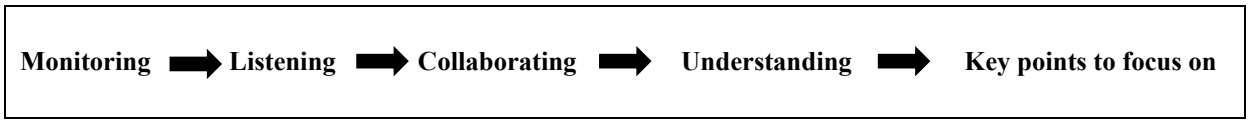

Figure 1: Pattern of teaching behaviour when using LbQ

The teacher had tried using *Accelerated Mathematics* in the past, but found that this resource did not lead to discussion and increased independence in the same way. It was found that the form of questions in LbQ led to more focused discussion of questions by pupils. It also led to persistence; one boy tried 97 times to get a question right; he did not guess the answer, he persisted in working out the way to answer it. The teacher found that LbQ was welcomed by boys particularly, as they did not have to write things down. However, with tests still done on paper, the teacher found that she needed to balance uses of LbQ with enabling pupils to work individually on paper.

Overall, the teacher found that LbQ supported pupil behaviours positively – they monitored their own learning better; they asked for help more; and they monitored their strengths and weaknesses better.

The teacher found also that LbQ saved time (but not for end-of-year reports). It saved time on marking and planning, significantly. The teacher also found that picking questions took less time than writing them, and that the form of questions in LbQ was appropriate for NI curriculum needs.

In terms of issues, some technical problems had arisen during the second year of use. The school wifi had failed, which was a major setback at the time, and clearly halted the use of LbQ when this arose.

5. CASE VIGNETTE 2

This post-primary school takes pupils from a catchment area that has levels of social deprivation, and where mathematics is regarded often by parents as something that 'can't be done'. The school has been using LbQ since October 2017. The acting principal reported that LbQ had been used to engage Key Stage 3 pupils in mathematics, particularly those who were finding mathematics a challenge. He said that engagement had been enhanced, and that this was visible in classrooms. He also reported that the school examinations levels in GCSE mathematics had risen by 15% from the results in the previous year, and he felt that LbQ was in part responsible for this increase. The principal indicated that this shift was arising as pupils were now being shown that 'they can do mathematics', with pupil commitment and questioning increasing.

The use of LbQ by teachers across the school varied. One teacher had used it in 113 lessons to date, while another teacher had used it in many lessons. A class observed (class 9, with pupils 12 to 13 years of age) contained nine pupils who had special needs in mathematics. The teacher had found that the boys did more using LbQ than when they wrote by hand in books. At the beginning of the lesson observed, books were handed out and the pupils were asked to write the title and date in them. The topic was a revision of square numbers. When asked what they had remembered from previous lessons, there was no response from the pupils. The teacher went over what a square number is, then handed out a 12x12 number grid, and asked pupils to mark all the square numbers (which they did). She also went over the ways to write a square number. Tablets were then given out, and the pupils were given an LbQ activity. Pupils immediately started to work on the tablets. Considering the length of time taken to write a title and date into their books, they answered by comparison a very high number of questions in a short time (10 questions were answered at a minimum and 20 at a maximum in the same time it had taken them to write the title and date in their books). As the lesson progressed, when pupils were not able to answer questions, the teacher stopped the class and went over these. Subsequently, pupils were able to answer the questions correctly.

Following some higher-level work, where pupils were more challenged, the teacher switched the topic to times tables, and set an activity on LbQ. Immediately, a high level of focus was observed. Within 5 minutes, one pupil had answered 47 out of 90 questions, at a lower level, one pupil had answered 19 questions in 6 minutes, while one pupil managed to answer all 90 questions in 10 minutes. The teacher said that the LbQ resource was very useful for re-engaging and re-focusing pupils during the lesson. She used LbQ, therefore, for parts of the lesson where she wanted to engage pupils as well as take their learning forward. She stressed that it was possible using LbQ to recognise the ability and learning of some pupils, which could not be seen when they wrote by hand on paper.

The teacher has been teaching groups of pupils who find mathematics a challenge for some time. She said that, from her experience, without using LbQ, she would have been 'exhausted' by the end of the lesson that was observed. LbQ was therefore having an effect on teacher wellbeing, was encouraging pupils to ask questions (which would not happen on paper) and to identify their areas of weakness. In a classroom where engagement is low, without the use of LbQ, there is clearly a high emotional level of concern by the teacher; with LbQ, the high level of concern is on the cognitive rather than on the emotional.

The teacher reported that she found that LbQ works well with GCSE groups, and that interest in use had been maintained by pupils across the two-year period. She also felt it had helped to gain higher GCSE results.

6. CASE VIGNETTE 3

This post-primary school takes a pupil population from across an area with levels of social deprivation; the FSM level in the school is 61%. In mathematics in the previous year, the GCSE level gained was 47%. LbQ had been used in the school since October 2017, and in the first year of use, four teachers were involved.

In discussion, the teacher said that LbQ keeps pupils on task more, and that questions are raised by pupils more when they use it. She also said that it highlights 'the silent' pupils more, who can then be appropriately supported. She said that she tends to use LbQ for parts of a lesson, often at the end of a lesson. She chooses question sets to match pupil needs, often choosing to start GCSE-setted classes on 'reasoning' questions straight away. She uses LbQ across all ability ranges in mathematics, and with all age groups. She says that pupils who are good at mathematics can move forward without hindrance when LbQ is used. With LbQ, all pupils gain immediate feedback, and differentiation support can be integrated easily into the lesson.

In a mathematics lesson observed, the initial activity involved the mixed ability group of pupils responding to questions using small whiteboards on which they could write answers and hold them up to show the teacher. The second activity involved using LbQ, and the questions focused on the topic of comparing and classifying triangles. The teacher went over a question that created a problem for some pupils, and after 5 minutes, some pupils had managed to complete four questions while others had completed 12. After 10 minutes, one pupil had answered 17 questions. When one pupil had tried a question 9 times, the teacher intervened and offered suggestions of what to do. After the teacher had offered advice to some pupils on one or two questions they found difficult, she reminded the class that 'reasoning' questions would be more difficult, and that pupils could work on these in pairs if they wished.

Twenty-five minutes after the start of the LbQ activity, only three pupils had not reached the 'reasoning' questions; by 26 minutes after the start, 5 pupils had reached the 'problem-solving' questions and 21 pupils had tried at least one 'reasoning' question. The teacher said that in the case of two pupils, they would not have reached the 'reasoning' questions in a more 'traditional' lesson where there was no use of LbQ. Pupils were clearly working their way through the questions, and using the technological facility offered easily, even though they had only used LbQ on two occasions before that lesson.

Overall, questions concerned with 'understanding' were covered by all pupils in 25 minutes. So, for this mixed ability class, 'delivery' using LbQ enabled understanding to be covered for all pupils in 25 minutes.

7. CASE VIGNETTE 4

This primary school takes pupils from across a wide social, emotional and psychological range. As an indication of the challenges the school faces, it is found that pupils may even have difficulty in 'sitting still'. LbQ had been used since October 2017, and was found to offer a positive stimulus for those who found it difficult to work with paper and pen. For other pupils, it was recognised that they could move forward using LbQ without needing to redo the things they might already know. In all cases, it was found that LbQ could provide pupils with instant success.

In a P6 class (with pupils 10 to 11 years of age), the lesson topic was fractions. Initially, the pupils were working on their own on iPads using LbQ. Some pupils found their answers were marked wrong, when in fact they were right. For example, the system did not recognise 'eleven –twelfths' (with the space before the hyphen). In this class, LbQ was used about three times a week. It was also used once a week for homework, and for homework the system marked the questions. Of the 17 pupils in the class, all said that they liked using LbQ in class, but 2 said that they did not like using it at home (in one case, because the father monitored use very closely).

Another P6 class (10 to 11 years of age) was involved in a literacy lesson on grammar. Each Wednesday, they used LbQ for homework – which they could access on a home tablet, personal computer (PC), laptop, mobile or Mac. Pupils said that they enjoyed using LbQ as it offered a break from other forms of activity, they got to use technology and learn at the same time, and they did not forget their homework. In terms of learning, the pupils said that they liked LbQ because it offered tips for getting things right, they gained good practice, learned from mistakes, gained instant marks, enjoyed problem-solving, different forms of questions, and gained help with different needs.

The teacher in this class said that LbQ was used between two and five times a week, while the IWB was used for an introduction or plenary activity, or for more standard teaching modes. She said that she could pick up easily when pupils were finding something difficult, and could ask a pupil to help another in this case (supporting peer teaching). Pupils worked in pairs for 'reasoning' and 'problem-solving' questions. LbQ was enabling practice for important activities, to provide for extra multiplication tables practice, for example. The teacher said that she could run three sets of questions together, and pupils did not know they were doing something different from other pupils (supporting differentiation in a positive way).

8. PUPIL-RELATED OUTCOMES AND BEHAVIOURS

From the case vignettes, teachers are reporting that LbQ supports independent working (not solitary working) and that it enhances self-confidence. This is in part due to the fact that pupils can identify readily when they are 'right' or 'wrong', that they can handle feedback and wrong cases better, and, using a number of strategies, are willing to learn from their mistakes. Consequently, pupils monitor their learning more and ask questions more. Pupils discuss questions, and engage in and enjoy problem-solving practices associated with collaborative learning approaches, such as those reported by Naujokaitiene and Passey (2019). Peer-support has been developed more, and it has been found that pupils are willing to support others more.

Use of LbQ has been found to support boys' engagement particularly. Pupils are seen to achieve more in less time. LbQ enables those who do not engage with writing to undertake tasks readily, and this means that using LbQ shows their ability across a wide range of tasks (which would not be possible to see if they were using pen and paper). Pupils with higher mathematical abilities say they can move forward without hindrance, and without needing to redo what they already know.

9. TEACHER-RELATED OUTCOMES AND BEHAVIOURS

Teachers are reporting that they are exploring ways to integrate LbQ with other activities and needs. Within lessons, and within a week, it appears that on average LbQ might be used in three lessons in a subject area, but in some cases, in almost every lesson. Some teachers use LbQ after another form of introductory starting activity.

LbQ is increasingly providing the delivery of content, so the teacher can undertake more monitoring, leading to real-time individual and group support. As it is known who has been able to answer the questions, teachers can put peer-support into practice more readily, and as needed. Differentiation is supported, as different question banks can be set up, and pausing to discuss issues with specific groups does not affect the progress of others.

It has been found that teachers can easily choose questions to match needs of different pupil sets. Teachers ensure and see that pupils move onto reasoning and problem-solving tasks as soon as possible. It is found that LbQ tasks encourage explanation and discussion. Pupils are seen to answer questions rather than choosing from multiple-choice alternatives, a behavioural shift also found when pupils use other digital resources (Radović, Marić and Passey, 2019).

LbQ saves teacher time in marking and planning. Pupil engagement is supported enormously, for all ability groups. Teachers feel much less emotionally exhausted when LbQ supports pupils who would not generally be strongly engaged in lessons. Certainly the relationship between misbehaviour in classrooms and negative effects on teacher wellbeing has been linked (Aldrup, Klusmann, Lüdtke, Göllner & Trautwein, 2018), and the potential positive effects of innovative technologies on wellbeing have been explored in some contexts (De Pablos-Pons, J., Colás-Bravo, P., González-Ramírez, T. et al., 2013).

10. DISCUSSION AND IMPLICATIONS

Across the schools, there is a general movement towards delivery of content using LbQ, which then allows teachers to have opportunities for more monitoring, questioning, encouraging of collaboration and greater understanding of cognitive issues and challenges. Teachers can monitor and support 'the silent ones' as well as all others.

When LbQ is used to enhance engagement of pupils in classes, where the level of engagement would generally be low, there is a movement from high emotional levels of concern by teachers within the classroom to high cognitive levels of concern. In classes where engagement is 'traditionally' low, this has a positive wellbeing effect on teachers. Teachers report being less exhausted and less emotionally drained. In these cases, where pupils increase the work on cognitive tasks, if pupils can 'talk it' and 'tech it' but not 'write it', the question is raised as to whether e-examinations could more positively support those with low handwriting engagement. E-examinations might support a more inclusive position, where pupils who cannot work with 'paper and writing' might show their abilities in mathematics (and other subjects) more.

Some schools are using LbQ for homework activities, in a form of 'flipped classroom' approach. In these cases, schools find that LbQ can be accessed on a range of devices in pupils' homes.

One school attributes a contribution from LbQ in its move in GCSE mathematics by an increase of 15% from the previous year. Clearly, increases in GCSE results that might be related to LbQ use are worthy of further study in future years.

Overall, pupil and teacher behaviours are being shifted as a result of using LbQ; there are cognitive, social and emotional shifts in both pupils and teachers. Cognitive shifts are concerned with enhanced subject and topic activity on task; social shifts are concerned with enhanced peer teaching and enhanced teacher monitoring; while emotional shifts are concerned with more positive teacher wellbeing and more open pupil support for others.

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30th June 2019

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