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Effects of technology-enhanced formative assessment on achievement in primary grammar

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Executive summary

Questions for Learning (QfL) is a technology-enhanced formative assessment technique in which pupils use electronic handsets to work through questions at their own pace in a classroom setting. The handsets provide immediate formative feedback to pupils and teachers, allowing teachers to quickly identify and resolve any learning problems or gaps. A previous study of QfL found strong positive effects on maths achievement in English primary schools. The present study reports findings of a 12-week study in which 42 primary schools in the north of England and Wales were randomly assigned to use QfL in the teaching of grammar in Year 5 classes, or to continue with ordinary grammar teaching. An additional 16 schools participated as a supplementary comparison group, in which the teachers had previous experience of using electronic handsets.

The current QfL study involved pupils using electronic handsets to respond individually to electronically presented question sets. Information about the rate and accuracy of the responses was immediately presented on the teacher's computer screen, which the teacher could then use to provide feedback and remediation for pupils. Pre-test and post-test assessments included discrete grammar questions. Although not an emphasis of the intervention, a paragraph revision writing task was included to investigate transfer of grammar knowledge to writing. Observations of QfL and control literacy lessons were made in half of participating schools and structured interviews were conducted with the teachers. Surveys by experimental teachers and pupils were completed at the end of the implementation period to assess their perceptions of using QfL.

The results show that on the grammar test, pupils in the QfL classes performed significantly better than control pupils, but these effects did not generalise to the writing task. Results of the evaluation suggest that QfL particularly supports average- and low-achieving pupils' learning of grammar concepts. If these results held over a school year, low- and average-achieving pupils would make between three and four months of additional progress. The teacher and pupil surveys conveyed highly positive responses to the use of QfL. Both teachers and pupils enjoyed using the strategy for formative assessment, believed it improved pupil achievement in grammar, and would recommend its use for other pupils and for other subjects.

Results of the evaluation suggest that QfL makes an important contribution to resolving the problem teachers face in identifying how the learning of each pupil is progressing in the lesson; which pupils require support; and which aspects of the curriculum require revisiting or re-teaching. QfL supports pupils' learning of discrete grammar concepts and promotes a positive learning ethos and culture in classrooms. The report concludes that teacher training and subsequent professional development

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in managing and responding to the extensive formative assessment data are essential for maximising the potential of QfL to impact on teaching and learning.

Introduction

Background literature

Extensive research has established that providing frequent formative assessment, to give both the teacher and pupils immediate indicators of pupils' current levels of understanding and that of the class as a whole, can have a substantial impact on learning (Black & Wiliam, 1998, 2009). Studies in the UK (eg, Black & Wiliam, 1998) and the US (eg Natriello, 1987; Crooks, 1988; McMillan, 2004) and elsewhere have shown that frequent formative assessments in daily classroom instruction can accelerate pupils' learning (Good, Grouws, & Ebmeier, 1983; Slavin & Stevens, 1995).

Research findings on the timing of formative assessment feedback have shown that immediate error correction during task acquisition can result in faster rates of acquisition (Clariana et al, 2000; Kulik & Kulik, 1998). Moreover, a study conducted with university pupils indicated that using wireless electronic handsets improved learning more than non-technological formative assessment strategies (Mayer et al., 2009).

Hattie and Timperley (2007) found that the most effective forms of feedback in classrooms are video-, audio-, or computer-assisted instructional feedback, related specifically to learning goals. They concluded that feedback supporting self-regulation is powerful in leading to further engagement with the task and to investing further effort into enhanced self-efficacy.

Kluger and De Nisi (1996) concluded that formative assessment feedback works by enhancing self-efficacy and self-regulation, such that attention is directed back to the task and causes pupils to invest more effort or commitment to the task. Importantly, the research evidence suggests that pupils' self-regulation of learning is best achieved through the opportunity to have more than one attempt at an answer.

Research has also shown that using an LRD permits normally shy or reticent pupils to participate through working independently and at their own pace, without being observed directly by peers (Barnett, 2006, in Mahon, 2012). Moreover, feedback appears to be more effective when there are perceived low rather than high levels of threat to self-esteem, presumably because low-threat conditions allow attention to be paid to the feedback (Kluger & DeNisi, 1996). Regarding individual pupils working independently and at their own pace privately, research suggests that feelings of self-esteem and self-efficacy are important in determining the effectiveness of feedback.

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Black and Wiliam (2009) point out that while the self-regulated learning literature pays scant attention to learning in the context of discourse, it is helpful to focus on the creation of moments of "contingency". These are defined as real-time adjustments in teaching. They involve decisions about teacher intervention, feedback and support based on the evidence provided by the formative assessment information and present possibilities for pupil discussion on learning that is or has taken place.

Feedback appears to have the most impact when goals are specific and challenging but task complexity is low (Kluger & De Nisi, 1996). Pupils' cognitive effort is therefore directed at the question rather than the mode of response.

The Questions for Learning (QfL) strategy

A recent development in the use of wireless electronic handsets allows pupils to answer questions at their own pace, providing instantaneous feedback to the pupils and their teachers about the pupils' understanding of the concepts just taught. Teachers should then be able to provide differentiated support to pupils, thereby improving their learning. In the QfL innovation, questions are delivered to pupils on the screen of their handset. As soon as they answer a question, the next one appears on the screen. An evolving graph, showing how each child is responding to and answering each question, immediately appears on the teacher's computer.

QfL allows the children who know the material well to steam ahead, and those who need more time to answer feel less pressured. It also permits the teachers to immediately see which children are struggling with the questions, so they can intervene right away to correct children's misunderstanding or provide additional support. If several children are getting many questions wrong, the teacher can pause the session and re-teach to the whole class, or a small group, the concepts or skills they have missed or do not understand.

Rationale for the study

The current QfL project was intended to enhance pupil motivation, engagement in learning, and pupil achievement in grammar. A seven-school randomised evaluation of the QfL strategy was conducted in primary schools in the north of England in spring 2011 to determine if technology-supported self-paced learning and formative feedback increases pupil learning in mathematics. The intervention produced positive

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effects on mathematics achievement. The present QfL study builds on that work to determine whether a similar approach could be successfully used to teach grammar.

In the QfL intervention, pupils used electronic handsets to respond individually to questions presented on them. Information about the rate and accuracy of the responses was immediately presented on the teacher's computer screen, which the teacher could then use to provide feedback and remediation for pupils. In light of the research cited above, QfL provides frequent, immediate feedback to pupils on their mastery of grammar skills. It provides reinforcement to motivate pupils to learn grammar and it enables teachers to quickly discover pupils' weaknesses and direct their support to those who need it most.

In summary, the QfL study was designed to evaluate a promising approach to grammar teaching with potentially important benefits for educational policy and practice. The evaluation's main questions were:

- Does QfL increase pupils' learning of grammar?

- What are teachers' and pupils' experiences of using QfL for learning grammar?

Supplementary questions were:

- Does the level of use of QfL predict pupils' grammar achievement?

- Does QfL work differentially for pupils of high, medium, and low ability?

- Does teachers' prior experience using electronic handsets make a difference to pupils' achievement outcomes?

- Does pupils' learning of grammar through QfL generalise to writing achievement?

Logic model

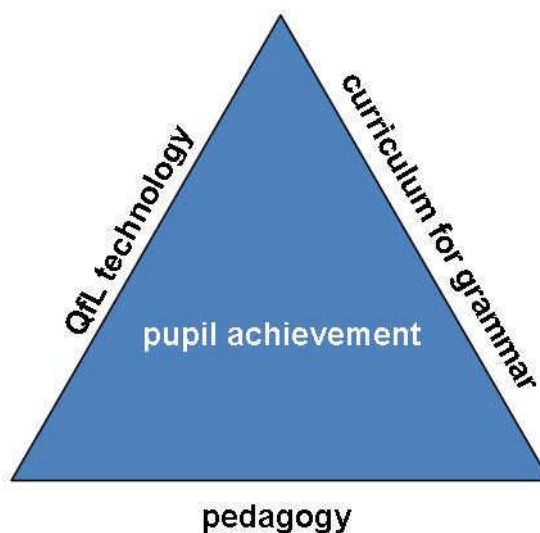The hypothesis underpinning the QfL intervention is that providing immediate feedback to pupils and teachers on pupils' responses using electronic handsets in focused grammar contexts would enhance teachers' formative assessment practices and pupil achievement in grammar.

Importantly, the project brings together pedagogy, QfL technology, and curriculum requirements in an integrated approach to improving the effectiveness of grammar

teaching and learning leading to enhanced pupil achievement in the domain, as represented in Figure 1.

Figure 1: Model of QfL for pupil achievement in grammar

The expected outcomes were higher levels of achievement in grammar for pupils who have experienced the intervention, evidenced by higher gains from pre-test to post-test scores, compared with the scores of pupils who have not experienced the intervention.

The main features of QfL that underpin our logic model are the provision of instant frequent feedback on pupil responses; increased opportunities for pupils' self-regulated learning; pupils working at their own pace in a private learning environment; challenging goals, low task complexity; pupil motivation; and an explicit support for teacher feedback and support. These are briefly explained below.

i) **The provision of instant frequent feedback on pupil responses**

Formative assessment information presented on the teacher's computer screen permits the teacher to give frequent feedback to pupils and support them individually, in small groups, and to the class as a whole while the activity is underway. This includes judicious pausing of the question set sequence to focus on a particular question or content focus. Empirical evidence from our previous study using a similar intervention showed positive effects of instant and frequent feedback on pupil engagement and learning in mathematics.

ii)   Increased opportunities for pupils' self-regulated learning

In our logic model, self-regulated learning means maximising opportunities for feedback on learning and helping how teachers manage this. Greene and Azevedo's (2007) model of self- regulated learning based on information processing theory, highlights features that support our logic model. Their model presents the following four stages, which translate to QfL:

- Identifying the task (What is the question asking me to do?)

- Planning a response (How do I answer the question? What do I do with the information presented to me?)

- Enacting a strategy (What keys do I press? What is my target for success?)

- Reviewing, adapting, and evaluating based on formative assessment feedback (Have I got the right answer? What answer should I give in my next attempt? How well have I done this time/overall?)

Central to the model is the learner's overall control and monitoring function which steers progress in learning. Pupils are encouraged to self-regulate their learning through the opportunity to have more than one attempt at answering questions with the electronic handsets in QfL. This self-regulation is expected to lead to enhanced pupil achievement.

iii)   Pupils in a classroom working at their own pace in a private way

This component relates to the affordances of electronic handsets for maximising opportunities for learning, how teachers manage these to promote learning in core curriculum domains, and how pupils engage with them to progress their learning.

Classroom observations conducted of QfL in our previous study (Sheard & Chambers, 2011) showed that an intervention similar to the one reported here clearly created a learning environment that developed and consolidated pupil learning in mathematics. We hypothesised that similar positive findings would be replicated in the present study.

iv)   Challenging goals, low task complexity and pupil motivation

QfL combines wireless electronic handset technology with a focus on curriculum requirements. The user-friendly appeal of the devices combined with clear, simple response modes permits pupils to concentrate their efforts on answering the questions and completing the set. In this way, the combination of challenging goals

and low task complexity provides opportunities for "flow" (Csikszentmihali, 1990). This is the sense of being completely absorbed in an activity because of its intrinsic interest and an optimal match between a learner's capability and the level of challenge presented by the task. This phenomenon was widely observed in our earlier study.

Pupils in our previous study in mathematics were highly motivated to use the devices for self-paced learning, and an earlier study by Van Dijk and Kluger (2001) confirmed the finding that positive feedback increases pupil motivation for a task. We expected that the combination of challenging goals, low task complexity and pupil motivation to use the electronic handsets in the proposed study would enhance pupil achievement in grammar.

v) Explicit focus on teacher feedback and support

Empirical evidence on this innovative use of technology for formative assessment has highlighted the decisions teachers need to make about when and how to intervene in the QfL session, how best to clarify concepts and address misunderstandings or misconceptions, and whether to re-teach some content. The most important consideration for teachers is how effectively their support to pupils is integrated with pupils' use of the learner response devices, so that pupil learning can be maximised.

For many teachers, having formative assessment data on the entire class very quickly presents a new opportunity to prioritise the focus of their teaching. This affects the teaching and learning environment and teaching practices, and may challenge assumptions that teachers have about individual pupils' learning capability. Teachers can provide immediate support to the pupils actually needing it most. This means that in every technology-enhanced self-paced learning lesson, no pupil's performance on the questions or learning needs could be overlooked. We predicted that these would be strong features of the intervention's implementation that would positively affect pupil achievement in grammar.

Method

Researchers at the Institute for Effective Education at the University of York conducted a cluster randomised evaluation of the Questions for Learning strategy (QfL) to determine if this approach increases pupil learning in grammar in Year 5 in UK primary schools.

The evaluation aimed to:

- provide information about the effectiveness of QfL in enhancing pupils' grammatical knowledge;
- obtain teachers' and pupils' perceptions of using the strategy;
- determine if the intervention is more effective for high, average or low-achieving pupils;
- determine if prior experience with electronic handsets impacts implementation of QfL and thus pupil learning; and
- determine if the effects of QfL generalise to pupils writing.

Evidence of increased learner motivation and engagement for learning grammar with QfL was sought through the use of pupil self-report, teacher report, and lesson observation tools. Teaching resources were delivered using a cloud-based system which produced trace data of QfL intervention usage. Computerised records of teacher log-ins to the QfL on-line system provided trace data of the frequency of intervention use in the classrooms and the level of pupil responsiveness. The data were used to investigate how these variables are associated with pupil achievement gains. More than 804,000 pupil responses were logged during the study.

Participants

Literacy advisers in nine local authorities in the north of England (Blackburn, Blackpool, Bolton, Lancashire, Liverpool, Bradford, Bury and Wigan) and North Wales (Flintshire), who had working knowledge of local schools, supported the recruitment of prospective schools. One Year 5 class from each of 42 primary schools participated in the randomised study. The schools were matched in pairs according to pupil attainment, free school meal eligibility, number of pupils enrolled, and geographic location. An overview of school characteristics is presented in Table 1.

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Table 1. School characteristics

School characteristics	Range	Mean
Number of pupils enrolled	110 - 975	346
% Free school meal eligibility	0 - 48.7	19.7
% SEN	0 - 40	21.3

The matched pairs were then randomly assigned to either use QfL (the intervention group, N=21) or not to use QfL (the control group, N=21).

In addition, Year 5 classes in 16 schools with previous experience of using ActivExpression learner response devices (AE) participated as a non-randomised intervention group to determine if prior experience with the electronic handsets impacted implementation of the intervention. One Year 5 class from each school participated in the evaluation. The QfL strategy was new to these schools, but not the use of the devices.

Procedure

The evaluation was conducted over 12 weeks between January and May 2012. Teachers in both intervention and control conditions were provided with the list of objectives to be covered during the study. Control schools received training in the use of QfL after the study was complete.

Teacher training

Training teachers to use QfL was an important part of the intervention. The training comprised of an initial classroom–based session and a later electronic training update.

Prior to the training sessions, teachers received instructions for downloading the vote manager programme and a set-up checklist. The format of the training was an in-person overview and practice session with teachers lasting two to three hours, followed by a practical session with the class.

Hard copies of the following training materials were supplied and formed the basis of the training. Digital files of the documents were also copied to the teachers' computers:

- Handset operation document

- Notes for teachers

- Additional teacher guidance notes

- Technical tips

- School set-up checklist

Teachers were asked to run at least three to four sessions per week to work through all the QfL activities in the study time frame.

Implementation

Forty question sets of 20 questions each were developed by Learning Clip, an English company that develops educational programmes delivered on interactive whiteboards (www.learningclip.com). The questions addressed the learning objectives for grammar in the Year 5 Term 2 curriculum, based on UK national expectations in the following areas:

- Nouns, adjectives and noun phrases

- Pronouns and pronoun agreement

- Verb tenses and agreement

- Adverbs and adverbial phrases

- Connectives

- Complex sentences

- Punctuating complex sentences

- Punctuating speech, direct and reported speech

Examples of the types of questions were: "Which is the verb in this sentence?"; "Which connective should go in the sentence?"; "Does this sentence have an adverb?"; and "Which sentence uses reported speech?"

The intervention took place for approximately ten minutes in literacy lessons and at other times in the school day. It was mainly introduced after teacher exposition, pupil

familiarisation with the curriculum content and learning goal, and some practice activity. Pupils responded to questions delivered to them on electronic handsets.

Intervention teachers were given the topics of every question set. Teachers were asked to use QfL at least three times a week for approximately 10 minutes in each class.

Sets of 20 questions closely related to the lesson's sentence level objectives were delivered to pupils on the screen of their electronic handsets, one question at a time, permitting the pupils to work at their own pace. A range of response modes were used across the question sets, including multiple-choice, yes/no, true/false, Likert scales and short-answers. The level of challenge gradually increased as the pupils progressed through the questions. As soon as the pupil answered a question, feedback appeared on the handset screen, indicating whether it was correct or not, followed by the choice to attempt the question again or go on to the next question.

The SPL questions were primarily discrete questions on particular objectives. A few open-ended questions were typically included in each QfL question set. The final question asked the pupils to write a sentence including the focus grammar feature, for example: "Write a sentence with a noun phrase in it"; "Write a sentence with a powerful adjective"; and "Change this sentence into direct speech." The QfL technology permitted teachers to display the sentences on the interactive whiteboard but did not score or provide feedback on the sentences pupils composed. Teachers were encouraged to share and discuss pupils' responses to the open questions with the class.

As the pupils answered questions, a table instantly updated on the teacher's computer screen. The teacher could monitor which pupils were answering which questions correctly or not, and how long they were taking. The teacher could then immediately help pupils who were making errors or stop the process to re-teach concepts that a number of pupils had not understood.

Observations and interviews

Evaluation visits were made to 14 classes in both treatment and control groups in the randomised control evaluation, and to 14 classes in the experienced user group.

For the implementation classes, QfL sessions were observed and interviews were conducted with teachers. During the interview, teachers were asked multiple-choice and open-ended questions. For the control classes, literacy lessons including grammar teaching were observed and interviews were conducted with teachers.

Measures

To provide a measure of pupil achievement, pupils completed a pre-test before the start of the implementation period and an equivalent post-test at the end of the study. The tests consisted of two parts. The main part was a set of grammar questions focusing on the national literacy objectives that were taught in both experimental and control classes. The focus of the questions was similar to those asked in the QfL sessions but the tasks and response modes were different and often more open-ended. For example, the tests required pupils to change the adjective in the sentence, change a statement into a question, and make two simple sentences into one compound sentence. In order to determine if improvements in grammar skills would transfer to a writing application, we also administered a revision task that asked pupils to apply their knowledge of grammar to enhance a simple narrative paragraph by re-writing it and including elements that had been covered in their grammar lessons.

Pre- and post-tests were constructed by devising two sets of parallel questions and randomly allocating one question to the pre-test and the other to the post-test. Similarly, for the revision task sets of five simple sentences that formed alternative opening paragraphs to a narrative were created and randomly allocated to the pre-test or post-test. Advice was taken in developing the tests from national experts in teaching and researching grammar and literacy. The tests were paper-and-pencil tests designed to assess equally the content emphasised in all groups. Overall reliability values of 0.70 were obtained for the pre-tests and post-tests using Cronbach's Alpha reliability statistic, which represents an acceptable level of test reliability.

The pre-tests were piloted for suitability of content, difficulty level, and timing with Year 5 pupils in a non-participating school. Towards the end of the evaluation, teacher and pupil surveys were completed. The teacher survey asked, for example, which if any ability groups of pupils made progress in grammar from using QfL; if pupils' writing benefitted, which aspects improved; and what if any are the main advantages of QfL grammar for teachers and for pupils. Examples of questions in the pupil survey include how much the chance to have another attempt at a question helps the pupil to learn grammar; how much has answering the questions on the handsets improved pupils' writing, and if it has, what has it improved most.

Data analyses

Primary analyses relating to differences between the new users and their controls, matched by schools, were conducted using Analysis of Covariance (ANCOVA) and

Hierarchical Linear Modelling (HLM). HLM, a more conservative analysis, takes into account the fact that pupils within schools are not independent of each other. ANCOVA, a more liberal analysis, uses the total number of pupils as its sample. It was used to analyse post-test differences on the grammar and revision measures between treatment and control groups, using pre-test data as a covariate to control for initial differences. Pre-test data were analysed for baseline compatibility using t-tests.

As the expectation was to implement QfL at least three times per week, three and above was used as a cut-off to determine high or low usage. HLM and ANCOVA analyses were conducted to analyse differences between pupils in schools in the new user group that used QfL at least three times per week and matched control schools.

To analyse for possible differential effects of QfL on different pupil achievement levels, the sample of new user and control treatment classes was split into high, medium, and low ability strands using the 33_{rd} and 66_{th} percentile on grammar pre-test scores. ANCOVAs were conducted to determine if there were differential effects for high, average, and low achieving pupils on their post-test scores, controlling for pre-tests.

ANCOVAS were also conducted comparing new users to experienced users to see if teachers' prior experience of using electronic handsets made a difference on pupils' post-test scores.

Lesson observations were conducted using an evaluation checklist. Observed teaching and learner behaviours associated with QfL were recorded and analysed using frequencies and item descriptions. Teacher interviews were analysed using thematic analyses of question responses. Teacher and pupil surveys were recorded, coded and analysed using descriptive statistics.

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Results

Quantitative findings

An initial t-test examined the equivalence of the experimental and control groups on the pre-test grammar measure. There were no significant differences, confirming that random assignment of schools produced equivalent groups.

The maximum score on the grammar pre-test was 27 for the experimental group and 29 for the control group. For the post-test, it was 30 for the experimental group and 32 for the control group.

On the grammar post-test, an ANCOVA controlling for pre-test scores found statistically significant positive effects (ES=+0.16, p<.001). This analysis is shown in Table 2. However, the HLM analyses did not find significant effects, and there were no positive effects for the revision/writing measure using either ANCOVA or HLM.

Table 2. Differences between QfL and control group on the grammar test

	Pre-test		Post-test		Adjusted Post
	Mean	**(SD)**	**Mean**	**(SD)**	**Mean**
QfL (n=489)	14.08	(5.12)	18.00	(5.31)	17.84
Control (n=461)	13.54	(5.25)	16.66	(6.22)	16.83

Effect size   +0.10 = not   significant   +0.16***

*** p<.001

The grammar effects were subjected to further evaluation to better understand the impacts of QfL. First, we analysed effects for pupils in the eight schools in which teachers used the devices at least three times per week, as the developers recommended. These results, shown in Table 3, indicate that in comparison to their matched counterparts in the control group, pupils in classes that used SPL with the recommended frequency gained more than their controls, with an experimental-control difference equivalent to an effect size of +0.27.

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Table 3. Control school comparisons for schools that used QfL three or more times per week

	Pre		Post		Adjusted Post
	Mean	**(SD)**	**Mean**	**(SD)**	**Mean**
QfL (n=489)	14.30	(5.04)	18.17	(5.19)	18.23
Control (n=191)	14.51	(5.02)	16.81	(5.80)	16.75
Effect size	-0.04 n.s.				+0.26**

** p<.01

A second focus of detailed analyses involved differential effects for pupils who were in the top, middle, or low third of the sample on the grammar pre-tests. As shown in Table 4, there were no significant effects of the use of the self-paced devices for high achievers, compared to equally high achievers in the control group. All of the programme effect was due to positive effects for average achievers (ES=+0.30, p<.003) and low achievers (ES=+0.26, p<.012).

Table 4. Differential Effects of QfL on grammar test for high, average, and low achievers

	Pre		Post		Adjusted Post
	Mean	**(SD)**	**Mean**	**(SD)**	**Mean**
High achievers					
QfL (n=160)	19.84	(2.43)	20.94	(4.12)	20.93
Control (n=139)	19.78	(2.63)	21.03	(5.21)	21.05
Effect size	+0.02 n.s.				-0.02 n.s.
Average achievers					
QfL (n=175)	13.98	(1.46)	18.27	(4.27)	18.24
Control (n=157)	13.85	(1.39)	16.57	(5.37)	16.62
Effect size	+0.09 n.s.				+0.30**

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Low achievers					
QfL (n=154)	8.23	(2.43)	14.64	(5.15)	14.55
Control (n=165)	7.98	(2.35)	13.05	(5.40)	13.15
Effect size	+0.11 n.s.				+0.26*
* p<.05					** p<.01

Finally, a non-randomised set of schools whose teachers and pupils were already experienced with electronic handsets, but not the QfL strategy, used the self-paced learning devices in grammar and were compared to matched new users. There were no significant differences between the experienced and new users in adjusted post-tests.

Qualitative findings

Findings from observation visits to implementation classes

Preparation and introduction to the QfL session

In all the lessons observed; a) interactive whiteboards (IWBs) displayed question set information; b) pupils had handsets allocated; c) all handsets were in working order; and d) the IWBs displayed question set information.

In eight out of 14 new-user lessons observed and 10 out of 14 experienced-user lessons observed, teachers' had their computer screens ready at the start of the QfL session to access and respond to formative assessment information on pupils' progress as they worked through the question set.

Teachers introduced the QfL session in various ways, including clarifying how to use devices, encouraging pupils to do their best; recalling previous work on different genres of writing such as myths and persuasion; referring to the bar that indicated where help was required; revising previous question sets; highlighting paragraphs of pupils' work on the IWB to identify grammatical features, and encouraging pupils to read the questions carefully and only to give answers as requested.

Preparatory pupil tasks included using mini whiteboards to write down examples of the grammar focus; identifying punctuation in text extracts; and paired discussion to clarify grammatical terminology and to rehearse grammatical rules.

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The majority of new-user teachers in QfL sessions observed made explicit links between previous teaching and the QfL session (10 out of 14); two teachers made partial links and two teachers made no links. Of the 14 experienced users observed, seven made explicit links between previous teaching and the QfL session; six teachers made tenuous links and one teacher made no link. Almost all of new-user teachers (13) and all the experienced users rehearsed the grammatical terminology to appear in the question sets with their class prior to running the QfL session. This included past and present tense, verbs and adverbs, direct and reported speech, connectives and complex sentences, nouns and noun phrases, and quotation marks and punctuation. Teachers used the grammatical terminology correctly; the exception was one case where the teacher's own subject knowledge of connectives was insecure.

Technological factors

Considering that this was a brand new use of technology and that there were over 804,000 pupil responses captured from 37 different schools (both new and experienced users), there were relatively few technological problems. Occasionally, technological problems interfered with the most effective implementation of the QfL sessions. These issues were usually resolved early in the implementation. In five out of 14 visits to participating new-user classes, technical problems were observed during the QfL session. Problems included technological interruptions, such as handsets freezing; question sets not restarting when the teacher paused the session for a teaching opportunity; the timer not restarting after a pause; questions freezing before 'time out'; and inability to access the display of individual pupil progress through the question sets. Teachers were encouraged to contact the trainer or their school's IT support person for solutions to these problems.

Teacher feedback and formative assessment

A range of question sets and associated learning objectives for grammar were addressed in the QfL sessions observed and focused on the following aspects: verb tense; pronouns; adverbs and adverbial phrases; direct and reported speech; using noun phrases to make writing more interesting; verb endings; using punctuation in complex sentences; and punctuating speech.

In the QfL sessions observed, eight out of 14 new-user teachers and 10 out of 14 experienced users had the response data displayed on their computer screen to feed back to pupils. This often commenced in the first couple of minutes into the QfL session.

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Using the progress bar that indicated how many children had answered each question correctly as a guide to pupil understanding and progress, nine new-user teachers interacted with the whole class, and one teacher interacted with a small group of pupils. Three teachers did not interact with pupils at all. Similarly, eight experienced users interacted with the whole class, none with groups, and four did not interact with pupils at all.

Of the new-user teachers observed, seven out of 14 paused the QfL session to address pupils' difficulties in answering questions or pupils' misconceptions. Of the experienced users, three used the pause facility.

All except two new-user teachers gave feedback to the class on their understanding of the grammatical concepts during the session. Where feedback was not given, the session had been disrupted and sent off course by technological interruptions. Teacher feedback during the QfL period focused on accurate reading of the questions and addressing the questions that pupils answered incorrectly. In addition, teachers often gave feedback to the class on general progress through the question sets and which problems were proving to be particularly problematic.

In the new-user classes observed, teacher feedback at the end of the QfL session usually clarified the grammatical terminology; how the grammatical feature functions in text, for example that an adverb, can change the meaning of a sentence; revisited questions that pupils found difficult, for example questions where a number of pupils had had several attempts at an answer; identified strategies for resolving errors, for example not to define an adverb as only with a spelling pattern '–ly' or '–ed'; and reading multiple choice options out aloud in turn to see which makes sense.

In the experienced-user sessions observed, seven out of 14 teachers gave feedback to the class on their understanding of the grammatical concepts addressed in the question sets.

Teachers indicated how a future lesson would build on the QfL session and learning outcomes in only two out of 14 sessions observed for the new users and in three out of 14 observed for the experienced users. In the sessions explicit links were made. For example, one teacher linked nouns, adjectives and noun phrases to descriptive writing about Amazon artefacts, and peer review of pupils' descriptive writing identified one 'green for growth' target, emphasising the noun phrase element.

Similarly, teachers set future learning goals for pupils' sentence level work linked to the observed QfL session in only four out of 14 sessions observed for both new users and experienced users. In the cases where learning goals were set, they included being able to identify examples of reported speech in selected texts and producing better descriptive writing by using well-chosen adjectives and noun phrases. An

innovative approach to linking the QfL session and formative assessment to pupils' writing was observed in one class where, at the end of the QfL session, pupils used post-it notes to identify two aims to improve their writing; later the pupils would refer to their notes to see whether these aims had been addressed. This strategy elicited pupils' commitment to using the formative assessment feedback to improve their writing.

Learner engagement with QfL and formative assessment

In new-user and experienced-user classes, pupils in all observed QfL sessions were on task and engaged for more than 75 per cent of the time. The exception was one class where the freezing of devices disengaged the pupils who were on task and engaged for approximately 50 per cent of QfL session time. Pupils worked mainly independently and asked the teacher for clarification or support rarely or not at all, with the exception of two classes where pupils often asked the teacher for help. Similarly, in seven classes observed, pupils rarely asked each other for clarification; six didn't ask at all, and one asked often.

In most cases, more than 75 per cent of pupils completed the question sets in the time available; in three cases, few pupils completed the question sets in the time available due to technical problems. In most classes pupils did not compete with each other on scores or completion times.

Summary of evidence from classroom observations

How teachers went about teaching

The strongest observed applications of QfL were as follows:

- Teachers often rehearsed the grammatical terminology to appear in the question sets and reported that as a result of QfL their teaching placed a greater emphasis on the technical language of grammar.

- Teachers interacted with individual pupils to resolve problems as soon as they were identified by the QfL technology.

- Teachers used QfL in various parts of the literacy lesson and at other times of the school day.

- Most teachers used the pause facility sparingly but effectively to address misconceptions or problems with specific questions with the whole class.

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Overall, in observed QfL sessions teachers were using the system and teaching as expected. The exception was the lack of clarity about linking the learning from the sessions to future literacy activity.

How pupils went about learning

- Pupils were highly engaged with the question sets for the duration of the sessions.

- All pupils started at the first question and worked through the question sets at their own pace. The majority of pupils completed the sets in the time allocated, and high achieving pupils usually worked through them quickly with plenty of time to spare.

- Pupils mainly worked independently and with perseverance.

- Pupils rarely asked the teacher for help during the QfL session; rather they generally demonstrated high levels of self-efficacy as learners.

Findings from teacher interviews

Utilising the formative assessment information

Some teachers reported using the formative assessment information to intervene right away where needed to support individual pupils early in their learning. Teachers also reported using the progress bar on the IWB to identify difficult questions, then pausing the sessions to re-teach concepts. Importantly, the assessment information was useful for challenging teachers' assumptions about which pupils needed help and permitted more targeted support to middle ability pupils.

At the end of the sessions, teachers identified the common questions that pupils found difficult. Teachers used the formative assessment information to inform their planning for focused lessons, for example constructing complex sentences, and to identify what needed to be revisited to reinforce learning. The information was also used to assign teaching assistant support to help individual pupils or groups of pupils.

Some teachers reported printing off the formative assessment information after the lesson to use later to feed back to pupils, to inform planning for individual pupils, and to keep as a record of pupil progress.

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Several teachers reported that pupils undertook 'Big Write' on Fridays, which permitted the pupils to engage in a sustained writing activity. Pupils were expected to incorporate what they had learned in grammar during the QfL sessions each week, using all the strategies derived from the formative assessment information to support pupils' writing.

Improving pupils' learning of grammar

Teachers reported that the formative assessment facility of QfL improved pupils' learning of grammar in several ways. Teachers identified increased pupil knowledge and use of grammatical terminology and noted improved use of adjectives and nouns in pupils' writing. In guided reading, pupils were using the grammatical terminology more and identifying grammatical errors in texts.

In teachers' opinions, the main benefits were to the lower-achieving pupils and reluctant writers, and also accelerated progress of those at Level 3. Benefits to higher-achieving pupils were noted in improved concentration on task. Teachers were surprised at how QfL made a positive difference to SEN pupils' learning. In particular, boys with challenging behaviour were very motivated to learn in this way. Teachers identified improvements in retention and recall in grammar work with the feedback facility of QfL. Teachers suggested that the formative assessment facility of QfL informed targets that teacher gave to pupils and supported targets being internalised and addressed.

Integrating the QfL session with the literacy lesson

Teachers' interview responses suggested that they had integrated the QfL session with the main literacy lesson in a variety of ways, including the following:

- To introduce, reinforce, assess and indicate what the teacher needs to focus on in the literacy lesson.

- To provide an assessment from a previous lesson.

- For one-off lessons, for example complex sentences.

- As practice and revision, referring back to what was taught previously.

- To introduce and reinforce the technical language of grammar.

- For discrete teaching and review to meet National Literacy Strategy objectives.

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Teachers reported that they addressed QfL grammar work objectives in literacy lessons in a variety of ways, including linking them to guided reading, texts and genres; linking whole class and individual targets to QfL objectives; going into more detail in grammar work than they would do normally, focusing on skills work; revisiting question sets when concepts need reinforcing; emphasising the consistency with a newly introduced assessment tool kit, and assessing pupil progress.

Overall, teachers reported using the QfL flexibly. For example, one teacher used the devices with two higher-achieving groups while other pupils did guided reading, and then used the devices with the lower-achieving groups. This allowed for different kinds of questions and interventions to address different pupils' learning needs.

Technological issues

Interviews with teachers revealed that 11 out of 14 new users but only four out of 14 experienced users experienced problems implementing the technology during the course of the evaluation. The variance of issues reported between experienced and inexperienced users suggests that the passage of time and increased familiarity with the technology would substantially reduce the frequency of technical problems. Reported problems were the same as those listed in findings from evaluation visits to QfL sessions. Often these were minor issues and only occasionally made the QfL sessions impossible to implement. These issues may be caused by factors other than the handsets, for instance; age and speed of teachers' computer equipment, quality and reliability of school networks / internet connections and variance in user ability with IT in general.

Findings on the application of learning from QfL to pupils' writing

Evidence from lesson observations and teacher interviews suggests that explicit links between QfL formative assessment outcomes and subsequent writing tasks or planned development of pupils' writing were infrequent. Where explicit links were in evidence, they included applying the grammatical features learned to a short writing task immediately following the QfL session, for example writing a short paragraph in the past tense about their week-end, or writing sentences including direct speech, quotation marks and adverbs. In one lesson in which a short writing task followed immediately from the QfL session, the teacher used a camera to display and discuss an individual pupil's writing with the whole class. This apparent lack of explicit links between QfL and pupils' writing may be one possible explanation for the lack of impact on pupils' writing.

Teachers reported making links between writing genres and their grammatical features. Several teachers also referred to the 'Big Write' session for extended writing at the end of the week in which pupils were expected to integrate their recent learning about grammar using QfL.

Many classrooms displayed pupil prompts to include grammatical features in writing, such as 'VPCO', representing vocabulary, punctuation, connectives and sentence openers, and desk-top punctuation pyramids. Explicit links between these resources and the QfL question sets and formative assessment feedback were rarely in evidence in lessons observed. An exception was the integration of a QfL session on using connectives to join sentences together in interesting ways into a writing review lesson; after the QfL session, pupils used the connectives displayed on the desk-top pyramid to review their own writing and to peer review the writing of other class members.

Survey findings

Teacher surveys

Findings are based on a 96 per cent return of teacher surveys (35 out of 37).

As there were few differences between the experienced and new implementers on their perceptions and attitudes toward using QfL, we combined the survey results.

- 94 per cent of teachers reported enjoying using the QfL for grammar quite a lot or very much.

- 80 per cent of teachers reported finding QfL quite useful or very useful as a formative assessment tool.

- 66 per cent of teachers reported using the computer screen display of individual pupils' progress through the question sets to feed back to pupils in most or all of the QfL sessions.

- 80 per cent reported that QfL helped their pupils to learn grammar quite a lot or very much.

- 91 per cent reported that QfL showed benefits in pupils' writing, with 80 per cent reporting benefits in pupils' writing of complex sentences; 77.1 per cent reporting improvements in pupils' use of connectives; 71.4 per cent reporting

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benefits in pupils' use of punctuation; 57.1 per cent reporting improvements in pupils' use of pronouns, and 54.3 per cent reporting that pupils' writing showed improvement in accurate use of verb tense.

- 74 per cent reported they would definitely recommend QfL for grammar to teacher colleagues.

Some survey questions invited teachers to give textual answers. Typical responses to key questions about the main advantage of QfL for teaching and learning are presented in teachers' quotes below.

What, if any, are the main advantages of self-paced learning grammar for you as a teacher?

"Great resources were provided-differentiated questions which stretched all abilities."

"Being able to spend time focussing purely on grammar work. Being able to assess the pupils' knowledge immediately."

"Immediate assessment. Review of progress. Constant evaluation-direct support."

"As a teacher, you can pinpoint which children are struggling with certain concepts and address this. You are also able to stop the lines and talk to children about a misconception at the exact point of misunderstanding. This tackles any bad habits in grammar which I believe benefits the child."

"It's a great way of teaching grammar – fun and child friendly. It allows me to see the areas of grammar children are finding tricky so I can revisit it with them."

What, if any, are the main advantages of self-paced learning grammar for pupils?

"A different and fun way to improve their grammar skills. They are able to see when they have made mistakes and have another attempt."

"The self-paced learning grammar allowed the children to learn more about grammar in a fun and engaging way. Children can work at their own pace. The programme was superb at following the strands of "nouns", "adverb", "adjectives", and so on."

"Motivational aspect especially for boys. Regular, discreet grammar sessions. Anonymity."

"Ease of use plus high level of motivation to complete question sets."

"Motivation. Having a quiet, focused class helps those children who find it hard to concentrate, do so."

Teachers were invited to add their own comments about QfL. The comments were highly positive. A selection is presented below:

"I have enjoyed immensely the chance to use the IEE pads, I can see the impact it has made on the children's punctuation. I am looking forward to increasing further the amount of time we spend using the system and I am very thankful for choosing our school as part of your research project."

"We have enjoyed using the devices very much. They have helped with learning and behaviour. Thank you."

"An excellent experience with the children. If the few glitches are worked out, we would definitely be interested in using this programme throughout the school (juniors). An extremely positive feedback from the pupils who all made significant progress, this is also reflected in their writing. Look forward to any future ideas!"

"It has been an excellent developmental and tracking tool that has enhanced the curriculum and pupil's learning".

"We have all enjoyed taking part in the project and I am sure the children have made progress. I have seen improvement in children's independent writing as a result of the self- paced learning input. I have found the programme particularly effective for a pupil in my class who is wheelchair bound and has limited use of his hands. He was able to perform at a very high level during these sessions as he was not limited by his inability to record things quickly-I think handsets and this type of activity are definitely the way forward for children like this."

Other representative quotes are presented in Appendix 1.

Pupil surveys

Findings are based on 95 per cent return of pupil surveys (994 pupil surveys returned from 35 out of 37 classes).

74 per cent of pupils reported enjoying using QfL quite a lot or very much.

76 per cent reported that the opportunity to have more than one attempt at answering a question helped them to learn quite a lot or very much.

65 per cent reported that QfL had improved their writing very much or quite a lot.

70 per cent reported they would like to use the devices and question sets in future literacy work quite a lot or very much.

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79 per cent reported they would like to use the devices in other subjects such as maths and science quite a lot or very much.

Quotes from pupils

Some survey questions invited pupils to give textual answers. Typical responses to key questions about the main advantage of QfL for teaching and learning are presented in pupils' quotes below.

"I think the whole of the UK should have one because they test your abilities in adverbs, nouns, pronouns, adjectives, and many more."

"I think they are a big help with all the questions because they teach you just a little more than what you know."

"I think they are very useful because if we didn't use them we wouldn't be independent. I would recommend them to other pupils because they help you a lot. Before it was boring doing grammar, now it's fun. I love them :)"

"It helps with giving you a boost, with things that you just can't quite understand."

"They give you chances to get your answer right. It is the best grammar gadget ever."

Other representative responses are presented in Appendix 2.

Discussion

The evaluation of the use of QfL to teach grammar to Year 5 pupils in English primary schools produced positive outcomes for grammar after a relatively short implementation period of 12 weeks. Analyses of covariance (ANCOVA) with a large sample of pupils in schools randomly assigned to use QfL or to continue with traditional teaching of grammar found that pupils who used QfL showed significantly greater gains on a grammar test. These differences were strongest in schools that used the devices at least three times each week, as prescribed, and they were strongest for low- and average-achieving pupils. If these results held over a school year, low- and average-achieving pupils would make between three and four months of additional progress.

The finding that QfL improves pupils' grammar achievement is not surprising. First, getting immediate feedback on their understanding of grammatical concepts can help pupils learn the technical language of grammar quickly. Receiving immediate information about who is answering questions incorrectly made it possible for teachers to intervene and correct misunderstandings right away.

The lack of impacts on high achievers is not due to ceiling effects, as average per cent correct for both groups was about half of the total possible score of 40. Instead, what happened is that low and average achievers closed the gap with high achievers in terms of their grammar skills, perhaps because the self-paced devices had a particularly large impact in adding motivation for pupils not usually motivated by grammar or perhaps because they identify and solidify skills that low and average achievers have missed in previous teachings.

The findings suggest, therefore, that low-and average-achieving pupils stand to gain more from the current QfL intervention in grammar than high achieving pupils. This seems to support research findings that feelings of self-esteem and self-efficacy, supported by pupils working at their own pace in a private learning environment, are important in determining the effectiveness of feedback. These effects were not directly assessed but if that is the causal mechanism, it could be particularly beneficial for average- and low-achieving pupils. The findings suggest that either high achieving pupils do not require the intervention, or that the level of challenge in the question sets should be reviewed to provide more appropriate challenge for high achievers. It could be the case that high achievers do not benefit as much as others from the security of the private learning environment and opportunity to enhance self-esteem and self-efficacy afforded by the electronic handsets. Alternatively, higher achievers may focus more on completing the question sets in record time rather than

embedding the learning. Future research could usefully seek to explore this issue further.

The findings show that QfL makes an important contribution to resolving the challenges teachers face in identifying how the learning of each pupil is progressing during the lesson, which pupils require support, and which aspects of the curriculum require revisiting or re-teaching. This is supported by teachers' reports that QfL often challenged their assumptions about pupils' levels of competence. In this way, QfL helped teachers to build more effectively and progressively on what pupils already know and can do. In turn, pupils were more engaged in their learning and this helped them to progress through the next stages of learning the grammatical features.

Findings from the present study suggest that the immediacy of formative assessment information to pupils using QfL at a critical moment in learning acquisition supports their learning more than the regular practice of formative assessment. Usually, formative assessment involves just a few pupils through short question and answer interactions or through marked work, homework, or unit tests/assessments. The findings suggest that increased opportunities for pupils' self-regulated learning, through the opportunity to have more than one attempt at answering questions with the electronic handsets in QfL, leads to enhanced pupil achievement.

Often challenging teachers' assumptions about particular pupils' prior learning and their current level of understanding, QfL feedback provided teachers with evidence of a number of different problems that negatively affected learners' achievement. Problems included pupils' misunderstanding the language used, misunderstanding the task, a misconception in the subject domain, or using an ineffective strategy to arrive at an answer. The intervention therefore focuses attention on teacher decision-making about questioning, feedback and support leading to better learning outcomes for pupils. It helps teachers to identify where re-teaching and/or new teaching are required at a relatively early stage in the teaching and learning process. However, it is important to recognise the potential demands on teachers that this unprecedented volume of data on pupil learning presents, and to consider how teachers might be best supported in knowing how to respond productively and effectively to the data on pupil responses. This will allow teachers to quickly address pupils' internalised conceptual misunderstandings that may otherwise hinder or delay their achievement.

While in lesson observations teachers rarely fed back to the class on how a future lesson would build on the QfL session, they used the formative assessment information later to inform their planning for future lessons and encouraged the pupils to use all the strategies derived from the formative assessment information in their

next writing session. This apparent delay in identifying and clarifying future learning goals and expected knowledge transfer suggests that teachers in the study needed time and opportunity to reflect on and make sense of the formative assessment information provided by QfL before sharing it with their pupils. This suggests that additional professional development to facilitate more immediate interpretation and synthesis of formative assessment data to inform the explicit identification of future learning targets and teaching strategies would be beneficial. In this way, the momentum for teaching and learning will be maintained.

The study's emphasis on providing training and support for teachers in their own schools on the technological aspects of the intervention is an additional benefit that will be attractive to practitioners. It has the potential to build capacity in the participating schools for practitioner skill and expertise in this area, and for promoting a whole-school focus on enhancing teaching and learning using proven technological tools.

The alignment of the QfL intervention's curriculum content to a revised national curriculum will provide support to schools in familiarising with and embedding national requirements in their own curriculum provision. Similarly, in reference to requirements for assessing pupil progress, the study highlighted the benefit of QfL in providing records that may be uploaded and saved, so providing clear evidence of pupil learning, achievement, and progress.

An important benefit is that QfL promotes a positive learning ethos and culture in classrooms. The teachers and the children really enjoyed the process. In most classes, you could hear a pin drop when the QfL sessions started. Each child was on task and focused intently on answering the questions. They often expressed disappointment when the session ended.

QfL has importance for policymakers in several respects. First, the intervention raises the profile of pupil engagement and achievement in grammar at a time when effective approaches to teaching grammar are being promoted nationally. Second, the study presents a new opportunity to focus on the effective use of technology as a pedagogic tool to enhance teaching quality through the provision of rich formative assessment data on pupil learning and progress and through the emphasis placed on teacher questioning and intervention skills.

Policymakers may particularly welcome positive findings for an innovative use of interactive whiteboards and learner response systems for enhancing teaching and learning, and so providing the opportunity to maximise the potential of the investment in educational technology in classrooms. Third, the results of the study will likely reinforce the intrinsic role of formative assessment in teaching and learning. It will

motivate policymakers to incentivise teachers and schools to implement formative assessment practices in general. The scope and potential applicability of QfL may be of particular interest to policymakers. The positive findings on pupils' achievement in grammar in the present evaluation may indicate how the QfL intervention could be successfully used to raise pupil achievement in other subject domains.

While QfL did not improve pupil's success in the revision task, teachers and pupils reported that it did improve their pupils writing in general. Perhaps the writing test may have presented a greater challenge to pupils than expected. While the writing genre was narrative, the test presented a short combined editing and composition task that may not be familiar to pupils and may not reflect their usual experience of writing.

There is more work to be done to determine how QfL in grammar, as part of a wider literacy curriculum provision, can effect improvement in pupils' writing. The challenge for teachers, policymakers and resource developers is to further understand the relationship between the discrete teaching and learning of grammar and pupils' writing.

This exploratory study of QfL conducted over a relatively short implementation period, is the first of its kind in grammar. It indicates what can be achieved in a short period of time, suggesting that higher levels of achievement might result from a longer implementation period, and provides important insights into what needs to be developed to improve the programme further, including a greater focus on empowering teachers with training to manage, interpret and respond to the amount and complexity of data provided by QfL. Recommendations are presented in Appendix 3 to enable this pioneering area of work to become increasingly effective in supporting the teaching and learning of grammar and other curriculum areas in the future.

Overall, the results supported the use of QfL as an effective approach for formative assessment to improve pupils' knowledge of grammar. It was particularly effective for average- and low-achieving pupils and in classes that implemented the strategy three or more times per week.

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Appendices

Appendix 1. Teacher survey responses

What if any are the main advantages of QfL for you as a teacher?

A selection of responses

A wide variety of activities associated with grammar. *Instant picture of how well the children are doing on a topic. *Assessment data stored on the website. *Excellent assessment tool.

Identifying the children (mainly boys) who answered well/correctly/quickly using the device who "normally" would not answer in class or show their ability in the work.

All children are actively involved in class learning.

It's a great way of teaching grammar – fun and child friendly. It allows me to see the areas of grammar children are finding tricky so I can revisit it with them.

You get instant feedback of understanding.

Ability to see how they answer in real time.

Very quick feedback as to whether the children have achieved the objective without lots of marking.

Can see any problem, instantly-and address them then and there (both individual and whole class)

Really easy way to track using "freeze" on projector-allowed me to see results on IWB or ipad.

I am able to focus on pupils that are struggling. A different approach for the class. I can target the areas of weakness now.

Being able to monitor the children in real time, spotting common mistakes and rectifying them.

What if any are the main advantages of QfL for pupils?

A selection of responses

Love using technology. Correct themselves as they go along.

Instant feedback. *It allows them to move at their own pace.

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A focused activity where they have to think independently. Personalised learning. They can get something wrong and then correct it without others knowing.

The self-paced learning grammar allowed the children to learn more about grammar in a fun and engaging way. Children can work at their own pace. The programme was superb at following the strands of "nouns", "adverb", "adjectives" as so on.

Independent learning with instant feedback.

Don't worry about what their peers are doing. Active involvement of all children all the time.

Immediate feedback.

Enjoyment. Focus. Consistency. Barrier Removal.

They all participate in an engaging way.

A different and fun way to improve their grammar skills. They are able to see when they have made mistakes and have another attempt.

Quick daily revision.

Consolidates knowledge.

It challenges them to think about grammar and analyse sentences more than they would normally do.

Enthusiasm, competitiveness, understanding of new terminology.

For lower ability pupils, it engages and ensures they are productive.

They have a certain amount of control over their learning-they can keep practising something without others knowing they are struggling.

Children work at their own pace and feel in charge of their own learning. For those with a competitive nature the 'position in class' function is ideal. They also love the handsets themselves and find them easy to use.

Additional teacher comments:

I've found the study extremely useful and feel that the children have benefitted from this opportunity. Thank you for allowing [our school] to participate in this study.

The self-paced learning grammar programme was fantastic and the class and I both enjoyed using it. The children were enthralled, engaged, and interested in the

handsets and learning was being done, each session. Some questions were sometimes misleading and extra support was given. After a few different ways of using them; an effective and efficient method was soon found. I didn't use the data I collected and would seek advice in how to use this more effectively. A superb programme, well worth the time, as I believe the children have progressed in their understanding of grammar.

My class is a top set literacy class and I have found that the handsets have highlighted gaps in the children's learning. It has made them think about using more connectives in their writing and made them aware of the noun verb agreement rules. I believe it has prompted them, in literacy, to think about commas, direct speech, complex sentences and compound sentences in a fantastic way.

I think this has great potential for use in the primary curriculum, I think that if I wasn't focused on completing the tasks within a set time period I may have used the activities more within my main literacy lessons as I feel they would probably be even more beneficial like this.

This, we feel, is definitely the way forward and we would like to continue teaching grammar using these resources in KS2. We are hoping that they will be still available to use now that the study period is complete. If anything, as a small school with two year groups in one class, it will be easier for us to incorporate the sessions into our literacy lessons now that we have more freedom to use the units and devices with the rest of the class.

The questions were well set and suitable for most of the children. They brought a new way of learning into the classroom. The ability to pause and then carry on didn't always work. Also some of the questions had wrong or more than one possible answer. On the whole a great learning resource well enjoyed by all.

Very helpful in the children's learning, however the class did become a little bored with the questions after a while. Different styles and types of questions may have helped with this. Also, a lot of the work was too hard for my lower ability children, but too easy for my highest. It has improved a lot of the class' grammar work though.

With constraints of the school timetable, I opted to use the handsets as an introduction at the start of each literacy lesson. Equally, this holds its own disadvantages as you need the children to finish in good time, in order to reach the lessons main objective. Some scores were also turning up as 100% even if it took a child five attempts to answer a question correctly. Is this misleading to a teacher?

The children and I have enjoyed taking part in this study. The devices are novel and the children certainly enjoy the challenge of completing the tasks and then finding out

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how they have done. I feel the impact on their writing has been varied yet their knowledge about grammar and understanding of the technical vocabulary has improved. As I said earlier, the children can all "talk" a good sentence and spot errors in sentences presented to them yet they still continue to make these same errors in their own writing.

I am in favour of this approach in theory. The main problem was that if I asked a question, most children would answer, hopefully correctly when given appropriate teaching. However, the same children regularly gave incorrect answers in self-paced sessions because they pressed something wrong, or couldn't spell or couldn't read or just that the syntax/structure of the question were clumsy and unclear on what was actually being asked.

Very pleased to see the obvious level of understanding improve in those children who find writing a physically challenging process. Weak readers needed support to read the questions, but have shown improvement. When we used them every day, the novelty wore off for the children and there were groans when we got them out. I can see many more ways that I would use them in Maths and English and other subjects now.

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Appendix 2. Pupil survey responses

What do you think about the devices and question sets?

A selection of pupil responses

I think they are very useful because they are quick not too quick though, but useful. They are useful because it shows what place you are on, what question you are on and gives you chances.

It helps you with your spellings, punctuation, adverbs, adjectives, nouns, verbs, adverbs.

They were very useful in literacy and I say they are fun to use and it was quite easy to do all the questions.

I think they'll be useful for other pupils because they're fun and help you learn as well so it's fun learning.

Very useful devices, has helped me a lot. If there wasn't a timer and everyone got to finish it would be even better. 5stars.

They will be very good for other schools to use because they help you for things you are a bit unsure about.

I think the questions were just right because there was some hard some easy and I think other schools will enjoy them too.

I think they are a big help with all the questions because they teach you just a little more on what you know. Yes I do think they will be useful for other children because other children will know what we know.

I think it is good for people who are not very good with their punctuation and spelling.

I think it would be good because they might not know where punctuation goes and how to speak.

I think they are very good and the questions help me a lot. I have been getting better at spelling because of the devices. You could maybe make more lessons on them.

When you get the questions correct in the test late in life you probably will get asked it again and think back to when you did the test.

I think they're very helpful and fun to use and if you get a question wrong I'm glad it lets you do it again.

I think it would be great for other pupils to use them because other children need to experience what grammar is like on a little pad. I think the handsets are very good because you know when your answer is right or wrong instantly.

I think this would be useful to other pupils because it brings a sense of technology to other subjects.

They were good because we have learnt more.

They would be good for pupils younger than Year 5 so they learn grammar quicker.

I think it will be beneficial and good because after I use it I felt confident.

I really like writing but some of the questions got me thinking! :)

It is like a mobile phone and some children don't like writing so going on the handheld devises, they might concentrate more.

I would recommend the devices to other people because it's more challenging when you have a time limit.

I think it would be useful for others as everybody has something that they struggle on and I did but I don't anymore because the handsets helped me.

If I don't win I don't mind, because I learn with the mistakes.

When you get the question wrong and then you have to try again helps you understand it a lot more.

They are quite useful and is nice and easy to use but after some time they get a bit boring.

I think they are helpful but do not help you with everything, plus they rush you by putting a position on you.

I think the handsets can be good and bad. Bad because some of the questions were actually right but the handset marked them as wrong and if you go on to the answer thing to see what everyone put is good but it has no capitals.

These handsets are an excellent way of learning grammar for pupils between 7-11 years of age as they help you to understand steps in grammar although some questions were wrong.

I like using the handsets but it is quite easy to make a mistake.

It's a bit useful but you can't fully punctuate your sentences.

I think sometimes I got a little bored with some questions but would like to use them in different lessons!

I think it could be useful to some schools in the future, but I think there should be different levels of difficulty.

They may be useful for other pupils- however personal opinion is the questions could be a little bit harder- or I think you could adapt the questions to the child's ability.

They are very fiddly and it takes a long time to clear after the questions. Some questions had the wrong answers set up and words spelled wrong.

I don't think it was very useful because some questions were very easy.

I don't like using the handsets at all. So to bring them into other subjects will be even worse. I also think that Qu.1 doesn't make sense because it has a time limit of 10 mins!!!

I did not like these handsets because they freeze, get answers wrong and difficult to use, I would not use handsets again.

If you check that the answers are right then you could let other pupils use them but some of the questions answers are wrong and sometimes they keep on freezing.

They were not useful. They didn't teach me anything.

I think the buttons and controls are extremely hard and the questions are quite tedious.

It got a bit boring after a bit with technical problems.

Appendix 3. Recommendations

The following recommendations are made for resource developers:

- As experiencing problems with technology in classrooms may have multiple root causes, it would be beneficial to assess whether, in a prospective user school, the technology system is of the standard and specification required to support effective programme implementation. Where it is not, recommendations should be made to the school about possible solutions or requirements to ensure that the intervention has a reasonable chance of success.

- Training and preparation for QfL in prospective implementing schools should adopt a co-ordinated approach to informing and involving key players at various levels of a school's technology support system, including IT technicians, server managers and external support providers.

- Developers and implementers should consider potential issues that might arise when integrating different platforms, (eg, working out how to avoid technological interruptions before implementation begins).

- Teachers should be encouraged to communicate with technical support staff immediately when issues arise.

- Review of the question sets should be undertaken and quality assured by an objective expert in grammar for writing to ensure the accuracy and appropriateness of questions.

- While teachers' and pupils' survey responses provide very positive support for QfL, the areas for improvement suggested by some respondents should inform future developments of the intervention (see Appendices 2 and 3).

- Training for teachers should include a half-day session on setting up, running and managing QfL, including maximising the affordances of the various features for teachers' efficient and effective management of formative assessment data. A second half-day follow-up training session should focus on teachers' strategies for managing and responding to the formative assessment data. Enhancing teachers' procedural knowledge in this way will support maximum impact of formative assessment information on pupil learning.

- Training for teachers should include encouraging teachers to consider how they will maximise the transfer of grammatical features learned in the discrete QfL sessions to pupils' writing.

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The following recommendations are made for teachers:

- Maximise the effectiveness and transfer of pupil learning with QfL, and place more emphasis on how it will feed into subsequent literacy work, and pupils' writing in particular.

- Where QfL sessions take place outside the main literacy lesson, make explicit links between them to ensure that discrete sessions do not lead to discrete learning.

- Make explicit links between the QfL objective and future tasks, writing genres, and writing opportunities.

- Identify specific writing goals or targets, based on the QfL question set grammar objective(s), and use peer/partner review to evaluate how successfully the targets were addressed.

- Use the strategy frequently, at least three times per week.

The following recommendations are made for policymakers:

- At a time when effective approaches to teaching grammar are being promoted nationally, promote the use of QfL to raise pupil engagement and achievement in grammar.

- Focus on the effective use of QfL technology as a pedagogic tool to enhance teacher questioning and intervention skills through the provision of rich formative assessment data.

- Maximise the benefits of investment in interactive whiteboards in classrooms to support formative assessment using QfL.

- Recognise and resource teachers' training and professional development as a necessary component of QfL intervention for effective implementation.

- Support schools' investment in the technological capacity required for effective implementation through a co-ordinated approach to technology support services including schools' IT technicians, server managers and external support providers.

Consider how the QfL intervention could be successfully used to raise pupil achievement in other subject domains.

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