

Improving pupil outcomes in science while reducing teacher workload Sacred Heart High School

Introduction

a) Problem: Describe the problem or issue your innovation addresses. What challenge(s) do your school(s) have that need to be addressed?

Workload is an issue that affects all teachers. Most teachers believe the effective use of ICT in the classroom can reduce workload and benefit the progress of pupils. However, evidence is lacking into specific approaches that demonstrate this. Learning by Questions (LbQ) is a classroom application that uses scaffolded questions and immediate feedback to develop pupil mastery of curriculum content. Real time assessment data from LbQ allows teachers to offer immediate intervention towards individuals or groups of pupils, without the need to mark pupil work.

Existing evidence: What existing research evidence exists?

What does the existing research evidence say about this problem and how it could be addressed?

The Department for Education (2014) Workload Challenge found that the three biggest areas that lead to unnecessary workloads are: marking, planning and data management. Hattie et al. (2008) identified feedback as an important strategy that enables pupils to make progress. If marking is the main way of providing feedback for pupils, these two findings illustrate a degree of dissonance between reducing teacher workload and enabling pupil progress.

An article by Selwood and Pilkington (2005) concluded that teachers believed the introduction of ICT has helped to reduce teacher workload. They reported that teachers expected that ICT could effectively be used to engage disaffected pupils, while allowing the monitoring of progress and performance.

The Institute for Effective Education (2018) reported that the use of Learning by Questions by

both primary and secondary school teachers resulted in a reduction in teacher workload of one to two hours and an improvement in pupil motivation and achievement.

The use of LbQ as a teaching and learning strategy is supported by McDaniel et al. (2007) who concluded that in the classroom testing can be used to promote learning, not just evaluate it. By providing teachers with real time assessment data on pupils, teachers can intervene immediately to pupil misunderstandings. This should accelerate pupil acquisition of knowledge as Kulik and Kulik (1988) found that immediate feedback is more effective in promoting acquisition of test content than delayed feedback.

It is hoped that the use of LbQ will be the ICT solution that not only remedies the conflict between teacher workload and providing pupil feedback but also results in better outcomes for pupils.

Innovation: Describe the innovation you will evaluate.

Give a brief description of the innovation. What existing research suggests the innovation will help improve the problem you have identified and benefit teachers and learners?

The innovation will investigate the effect of LbQ on Progress Test in science scores for Year 7 pupils at Sacred Heart High School.

Sample: Approx. 160 Year 7 pupils.

There are eight sets in Year 7 who are allocated based on end of Year 6 CAT (Cognitive Abilities Tests) scores. Sets 1–4 are mixed higher prior-attainment. Sets 5–6 are mixed middle prior-attainment and sets 7–8 are lower prior-attainment.

Sets 1–2, 5–6 and 7–8 will take part in the study, each pairing representing low, medium and higher prior-attainment groupings.

Innovation: LbQ will be integrated into the curriculum of the intervention group. LbQ science question sets have been mapped to the Sacred Heart Year 7 schemes of work:

Year 7	
Topic	No. of Q sets
B1 – Cells	7

B2 - Structure and Function of Body Systems	3
B3 – Reproduction	8
C1 – Particles and their behaviour	5
C2 – Elements, atoms and compounds	5
C4 – Acids and Alkalis	2
P1 – Forces	5
P2 – Sound	2
P3 - Light	3
P4 - Space	2
Working Scientifically	17
Total	59

All teaching groups will receive a summary lesson at the end of each topic.

The control groups will receive a standard hour-long end of topic summary lesson and starter activities.

The intervention group will receive an hour-long summary lesson that uses LbQ and LbQ 'Working Scientifically' question sets will be completed as starter activities across the year.

Note: A maximum of three question sets will be used in a summary lesson. Every additional three sets will receive an additional revision session e.g. Year 7 topic B3 will require three LbQ summary lessons. The control group will receive extra non-LbQ summary lessons where necessary to ensure both groups receive the same summary time.

The project coordinator will create a log for intervention group teachers to ensure that each question set is completed at the appropriate time.

The evaluation will run for one whole academic year.

All pupils involved in the trial will take the GL Assessment Progress Test in science at pre- and post-testing to provide standard age and stanine scores in biology, chemistry, physics and working scientifically. The tests are paper based and will be marked by GL Assessment. We would expect the results of the post-test to show that pupils in the intervention group will make greater levels of progress.

Control and intervention teachers will take an online survey at the start and end of the trial to evaluate the impact of LbQ on teacher workload.

The findings of Hattie et. al (2008), McDaniel et al. (2007) and Kulik and Kulik (1988) all provide evidence into the potential efficacy of LbQ as it provides instant feedback to pupils. The self-assessing nature of LbQ allows teachers to assess understanding and address misconceptions in a highly targeted and differentiated manner.

The Institute for Effective Education (2018) reports a reduction in teacher workload by one to two hours when using LbQ. Therefore, the integration of LbQ into the curriculum should benefit teachers.

Research question(s) or hypothesis

What effect will the intervention, implemented for how long, with which pupils, have on which outcomes?

What effect will the use of Learning by Questions over one academic year with Year 7 pupils at Sacred Heart High School have on scores in the Progress Test in science?

What effect will the use of Learning by Questions over one academic year with Year 7 pupils at Sacred Heart High School have on teacher perceived workload?

Method: Describe exactly how the evaluation will be conducted

Sample

Who will participate in your evaluation? What consent will be gathered for them to participate? Briefly describe the key characteristics of the setting and participants.

Approximately 160 Year 7 pupils.

Parents will be informed of the evaluation, while reassuring them that no pupils will be unfairly disadvantaged. An opt-out will be offered to parents if they do not wish for their child's data to be collected and shared with third parties.

Pupils will be taught in school science labs with access to standard school science lab facilities. Class sizes are approximately 30 for sets 1–2 and 5–6 but there are approximately 20 pupils in sets 7–8. Approximately 25% of pupils at Sacred Heart are eligible for pupil premium.

Assignment to condition

How will you allocate participants to the intervention and control groups?

Allocation has been carried out using a coin toss to ensure randomisation.

Year 7		
Control	Intervention	Subgroup
S (1)	A (2)	High prior attainment
D (5)	E (6)	Medium prior attainment
T (7)	H (8)	Low prior attainment

The teachers allocated to each class are done so by the head of science. This is not something that can be reasonably controlled due to the complex nature of timetabling in school.

Innovation

Describe your innovation in detail.

Stage 1

1. September 2019 - Pre-testing of control and intervention pupils using GL Assessment Progress Test in science. Paper assessments will be used in the dining hall. These are marked by the GL Assessment.
2. September 2019 – Initial meeting with teachers taking part in the evaluation. LbQ logs to be given to staff so that they can log when they have completed each question set.

Stage 2

1. September 2019 - Intervention group teachers to run an introductory lesson to LbQ in the first two weeks for teaching. Chemistry topics to be used:
 - Basic lab apparatus,
 - Combustion: using a Bunsen burner,
 - The fire triangle and fire extinguishers.

The first six lessons of the year are “Introduction to science and safety” lessons so these “working scientifically” topics will fit in effectively.

2. September 2019-June 2020 - Intervention group teachers will teach the standard Year 7 scheme of work but will end each topic with an LbQ summary lesson. Teachers will monitor pupil progress and address misconceptions in real time.

Teachers will run a maximum of three LbQ tasks per summary lesson. Working scientifically question sets will be used as starter activities throughout the year. Teachers will be asked to complete a number of LbQ starter sessions throughout the year. They can choose to use these when they wish but must complete a designated group of set by the end of each half term.

Teachers will be asked to complete their LbQ log to ensure that they are completing the correct starter activities in the correct terms. The project coordinator will monitor this during end of term review meetings.

Year 7

Topic	No. of Q sets
B1 – Cells	7
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B3 – Reproduction	8
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C2 – Elements, atoms and compounds	5
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P1 – Forces	5
P2 – Sound	2
P3 - Light	3
P4 - Space	2
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Starter LbQ Log – to be given to intervention teachers in Sept 2019

Question Set	Term to complete by	Done?
Complex units	SPRING	
Converting units with prefixes - deci, centi, milli	SPRING	
Converting units with prefixes - mega- kilo -	SPRING	
Basic Laboratory Apparatus	INTRO IN SEPT	
Apparatus for Heating	AUTUMN	
Drawing Laboratory Apparatus	AUTUMN	
Combustion: Using a Bunsen Burner	INTRO IN SEPT	
Combustion: The Products	AUTUMN	
Combustion: Complete and Incomplete	AUTUMN	
Combustion: The Fire Triangle and Fire Extinguishers	INTRO IN SEPT	
Simple units	SPRING	
Using Equation Triangles to Rearrange Equations	SPRING	
Symbols and Names for Units with Prefixes	SUMMER	
Symbols and Names of Quantities in Physics	SUMMER	
Units in Physics Mixed Questions Set 1	SUMMER	
Units in Physics Mixed Questions Set 2	SUMMER	
Units in Physics Mixed Questions Set 3	SUMMER	

The control groups will receive a standard hour-long end of topic summary lesson and starter activities.

3. End of term review meetings will take place as part of a process analysis at the end of the autumn and spring terms to ensure intervention teachers are completing an appropriate number of questions sets and to provide an opportunity to offer any feedback.

Stage 3

1. June 2020 – control and intervention groups to complete an end of year GL Assessment Progress Test in science. Again, this will be a paper assessment that is marked by GL Assessment.
2. June 2020 – intervention teachers to complete an end of year questionnaire to provide information on how they feel LbQ has impacted their workload.
3. July 2020 – project coordinator to collate data and write final report.

Outcome measures

What outcome measures will you use? When and how will they be administered and scored?

Impact on pupil progress

This will be measured through completion of the GL Assessment Progress Test in science, which will be administered through an online digital assessment. This will be completed in an ICT suite during the first two weeks of the September start date. Scoring is carried out automatically by the GL Assessment software.

Impact on teacher workload

Suggested questionnaire:

1. How difficult was it to use LbQ with your class over the past year? Please provide additional information to support your choice.

1 = extremely difficult

2 = quite difficult

3 = easy

4 = very easy

2. How much time providing feedback does using LbQ require of you in comparison to how you would normally give feedback? Please provide extra information to support your choice.

1=significantly less time than normal

2=less time than normal

3=same time as normal

4=more time than normal

5=significantly more time than normal

3. How likely are you to use LbQ in the future?

1= very likely

2= likely

3= unlikely

4= very unlikely

4. Would you recommend LbQ to a teacher who wants to reduce their planning workload? Please provide extra information to support your choice.

1= Yes

2 = No

5. Tell us something about the time you have saved by running a question set (e.g. planning, marking assessments)? *Open ended.*

A pupil questionnaire will be conducted at the end of the year to provide feedback to the IEE and LbQ, however, this will not be included in the final report.

Process analysis

What data will you gather for the process analysis?

The end of autumn and spring term review meetings will involve the project coordinator (myself) meeting with the intervention teachers to confirm the following:

1. Have they completed the topics that they should have?
2. Have they completed the correct no. of LbQ summary lessons for the topics?

3. Have they used the correct no. of LbQ activities as starter activities?
(1-3 can be checked by looking at teacher logs.
4. Were there any issues when using LbQ that need to be addressed?

If teachers feel that the intervention is not being used appropriately, then we could look at how this could be improved and the project coordinator would seek the approval of the IEE to see if they agree that amendments to the evaluation need to be made.

Starter LbQ log – to be given to intervention teachers in Sept 2019

Question Set	Term to complete by	Done?
Complex units	SPRING	
Converting units with prefixes - deci, centi, milli	SPRING	
Converting units with prefixes - mega- kilo -	SPRING	
Basic laboratory apparatus	INTRO IN SEPT	
Apparatus for heating	AUTUMN	
Drawing laboratory apparatus	AUTUMN	
Combustion: using a bunsen burner	INTRO IN SEPT	
Combustion: the products	AUTUMN	
Combustion: complete and incomplete	AUTUMN	
Combustion: the fire triangle and fire extinguishers	INTRO IN SEPT	
Simple units	SPRING	
Using equation triangles to rearrange equations	SPRING	
Symbols and names for units with prefixes	SUMMER	

Symbols and names of quantities in physics	SUMMER		
Units in physics mixed questions set 1	SUMMER		
Units in physics mixed questions set 2	SUMMER		
Units in physics mixed questions set 3	SUMMER		

Topic log – to be given to teachers in Sept 2019.

Question Set	Year	Topic	Done?
Cell structures: comparing plant and animal cells	7	B1	
Specialised cells: an overview	7	B1	
Specialised animal cells	7	B1	
Specialised plant cells	7	B1	
Using a microscope	7	B1	
Making and observing microscope slides	7	B1	
Cells vocab	7	B1	
The structure and function of the respiratory system	7	B2	
Levels of organisation	7	B2	
Structure and function of human skeleton	7	B2	
Structure and function of female reproductive system	7	B3	
Structure and function of male reproductive system	7	B3	
Human life cycle and puberty	7	B3	
Menstrual cycle	7	B3	

Fertilisation and implantation	7	B3	
Foetal development and birth	7	B3	
Human reproduction vocab	7	B3	
Sexual reproduction in plants	7	B3	
Properties and arrangement of particles in a solid, liquid and gas	7	C1	
Changing state	7	C1	
Diffusion	7	C1	
Heating and cooling curves	7	C1	
Particle model vocab	7	C1	
Atoms and elements	7	C2	
Compounds and mixtures	7	C2	
Naming simple compounds	7	C2	
Periodic table: basics	7	C2	
Element names with symbols	7	C2	
Properties of acids and alkalis	7	C4	
Neutralisation	7	C4	
Understanding forces 1: Balanced forces	7	P1	
Understanding forces 2: Unbalanced forces	7	P1	
Forces vocabulary	7	P1	
Weight = Mass \times Gravitational Field Strength Equation and Calculation (With Equation Triangles)	7	P1	

Weight = Mass × Gravitational Field Strength Equation and Calc	7	P1	
Waves basics – light and sound	7	P2	
Amplitude and frequency of sound waves	7	P2	
Dispersion of light	7	P3	
Reflection and refraction of light	7	P3	
Reflection of coloured light	7	P3	
The Solar System (note under physics on LbQ)	7	P4	
Day and night, years and seasons	7	P4	

Analyses

How will you analyse your outcome and process data?

The mean SAS (standard age score) for the control and intervention groups with 90% confidence bands are provided by GL Assessment's Progress Test in science.

This will be collected for each class after both the pre- and post-test.

The difference between mean scores of the pre- and post-test results will be calculated along with an effect size as shown below. In theory all classes should show some improvement in the post test compared to their pre-test result.

Year 7		
Control	Intervention	Impact on
S (1) Pre-test score vs. post-test score	A (2) Pre-test score vs. post-test score	High prior- attainment

D (5) Pre-test score vs. post-test score	E (6) Pre-test score vs. post-test score	Medium prior-attainment
T (7) Pre-test score vs. post-test score	H (8) Pre-test score vs. post-test score	Low prior-attainment

A comparison of matched classes will then take place. This will be the amount of improvement of the intervention group against its matched control group.

Control vs intervention	Impact on
S (1) vs A (2) Difference between pre and post vs. difference between pre and post.	High prior-attainment
D (5) vs E (6) Difference between pre and post vs. difference between pre and post.	Medium prior-attainment
T (7) vs H (8) Difference between pre and post vs. difference between pre and post.	Low prior-attainment

Conclusion

Potential limitations

What are the potential limitations of your design?

Potential limitations include:

- The small sample size for high, medium and low prior attainment classes.
- Possible inability to compare the control and intervention teacher questionnaires due to

the control teachers not doing the intervention (this may be possible but hinges on a teacher being allocated two Year 7 classes next year). The solution would be to compare the before and after questionnaire results of the intervention teachers only.

- Possibly being unable to match the number of FSM/PP/SEND pupils between classes.

Implications

What would you do if your results were positive? What about if results are negative or neutral?

If positive or negative I would recommend scaling up the research to determine whether the results could be replicated in other school settings.

If positive I would share my findings and actively encourage other teachers to use LbQ for the benefit of their pupils.

References

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