Spaced Learning Programme Development Project

Queen's University Belfast
Liam O'Hare

PREAMBLE

The following protocol will act as a guide to activities and responsibilities for the spaced learning project. The project is conceptualised as an early phase design and feasibility study rather than a efficacy or effectiveness trial. Due to the design focused nature of the project, it will require extensive collaboration between the research and practice teams. Therefore, there is much overlap in responsibility for specific project tasks and their delivery. This shared responsibility will produce a shared output in the form of a co-authored/produced 'spaced learning' programme manual, which will form the materials for future efficacy or effectiveness trials.

Evaluation Summary	
Age range	13-15 (Year 9)
Number of pupils	1500
Number of schools	15 (all year 9 classes)
Design	Early phase design and feasibility
Primary Outcome	Science Attainment

BACKGROUND

Significance

Spaced Learning (subsumed under the distributed learning literature) is an effect proposed and studied since the late 19th century. In essence, it proposes that learning which occurs with spaces (i.e., elapsed time) between the repeated presentation of information is retained better than massed learning where all information is presented at one point in time. The important requirement is that both repeated and massed presentations all total the same amount of time on the topic being learned.

The neuro-scientific explanations of the spacing effect are understudied and largely based on cellular experiments showing stronger neural connections are made by spaced firing rather than longer (massed) firing (Fields, 2005). The majority of review literature on spaced learning has mainly focused on the duration of the elapsed time between learning presentations (e.g. minutes vs days) and the duration of retention (days vs months - Cepeda, et al. 2006). Despite recent demonstrations of the efficacy of 10 minute time intervals (Kelley & Whetson, 2013 drawing on the Monkseaton High School spacing studies), the general research consensus from several meta-analytic reviews is that longer gaps produce better learning outcomes, particularly for information that has to be retained for longer periods of time (Cepeda et al., 2006; Carpenter et al., 2012). Furthermore, research has mostly looked at basic cognitive outcomes e.g. memory recall. However, a review of 120 studies of spaced learning (Moss, 1996) showed significant effects in 80% of the studies looking at recall and motor performance, but only one third of studies which included cognitively more complex tasks (i.e., higher order cognition), which should be of concern in an intervention focused on improving attainment. Therefore the service design element of this proposal will consider ways to develop and test feasibility of a spaced learning intervention that has the maximum potential to impact on cognitively more complex outcomes and ultimately attainment.

There is limited research on how tasks completed in the elapsed time spaces affect the target learning. However, there is a growing evidence base on 'interleaving' where different materials are studied in the same sessions/days rather than grouping similar materials together. This is supported by the discriminative-contrast hypothesis, which suggests that presenting different learning content in in the same sessions re-enforces the learning of different topics. There is a relationship between interleaving and spaced learning designs. Where spaced learning designs typically schedule presentations of a single concept/fact, interleaving designs involve the scheduling of multiple concept facts (Rohrer, 2012). This relationship is likely to be particularly crucial in the context of more authentic classroom based science learning where the focus of the learning is likely to be on multiple concepts rather than on single concepts/facts.

Intervention

The purpose of this research is to design and test the feasibility of an intervention based on spaced learning principles. Therefore, there is no specific programme manual or programme logic model available at this stage as these are intended outputs of the project.

RESEARCH PLAN

RESEARCH QUESTIONS

The research questions in this project focus on design, feasibility and implementation of a 'spaced learning' programme rather than evidence of efficacy of effectiveness. Therefore there are two main questions in the project.

1. What does evidence and practice suggest is the best design of a 'spaced learning' programme with potential to produce effects on science attainment outcomes?
2. What can we learn about the feasibility of implementing a 'spaced learning' programme in a practical classroom situation?

METHODOLOGY

This project is focused on the design and feasibility of an intervention constituting an early phase 'proof of concept' before conducting future trial research to identify potential effects of the programme. As such there will be three phases in the methodology (following those highlighted by Craig et al., 2008):

Design

1. Theoretical development (months 1-6)

Why should this 'spaced learning' programme work? To explore this question, there will be several stages in the programme design process.

A structured literature review of 'spaced learning' interventions will be conducted covering the elements of a standard logic model (i.e., inputs (resources), outputs (activities) and outcomes (changes), assumptions (e.g. training, quality and engagement) and external factors (current 'spaced learning' practice and proliferation as well as the educational context). The literature review will also look at underpinning theory around spaced learning in terms of a theory of change and a theory of intervention. This literature review will take multiple perspectives on spaced learning i.e., from neuro-scientific, cognitive psychological and practice perspectives.

Ultimately, this literature review is being conducted to feed into a service design and logic modelling process. This process will be a collaboration between a range of stakeholders: the research team (QUB), the service delivery organisation (Hallam TSA); school principals; teachers; and external practitioners. The process will begin with a programme development retreat and include: capacity building in logic modelling; presentations on spaced learning literature; and current spaced learning practice. The retreat will also adopt elements from 'A futures workshop' methodology to frame the discussions (Jungk & Müllert, 1987).

The logic model produced during the retreat will then inform the design of a spaced learning programme (it is envisaged there will be several variants of the programme at this stage). These early models will be further explored with a group of teachers and the project team to develop activities, PowerPoints, training, and lesson plans etc. which will go to produce a draft spaced learning programme manual.

2. Feasibility testing (months 7-15)

Having produced a draft manual in the first phase, feasibility testing will then explore the implementation of the programme (and it variants) in practice. This feasibility testing will be broken into two parts.

Part 1

The first part will see the project team work closely with a small number of schools (n=3). Initially, the teachers in these schools will be trained on delivery of the emerging spaced learning programme and its variants. They will then attempt to implement the programme variants in their respective schools. After these initial feasbility tests there will in a repeat of the co-design workshop modelled on the 'Future Workshop' methodology (Jungk R, 1987), encouraging participants to critique existing materials and using participatory design methods to further develop the draft manualised intervention. The workshops will include staff from the three test schools (n=2 from each) and a similar number workshops with pupils from the 3 schools. During these workshops we will ask the following questions: does the programme work on the ground? What is the acceptability of the programme to those delivering it and to the young people receiving it? What is the best way to deliver the programme? Was the delivery model successful and sustainable? Was the programme the right length? Were the teachers showing fidelity to the draft programme manual? Were the school leaders, teachers, and pupils engaged with the programme? Would delivery quality be sustainable? Does the programme enhance or inhibit current activity to enhance science learning in schools?

Part 2

The next part of feasibility testing will be to look at a larger number of schools (N=12). These schools will implement refined versions of the variants explored in the first part of feasibility testing. Again, teachers in these schools will be trained on the spaced learning approach and asked to implement it in their schools. This time there will be a 'business as usual' control in some of the schools for comparison purposes. Please note that these comparisons are not being made with regard to efficacy but rather on implementation issues. Data will be collected quantitatively (through a post-test implementation questionnaire and pre-post outcome measures – see measures section).

3. Review and final manual production (months 15-18)

The final phase will see qualitative and quantitative findings fed back into the logic modelling process. Final refinements will be made to the programme design and choices about what variant of the programme worked best. These decisions will be made in a series of meetings between the research and practice teams.

These discussions will produce the final output in the form of a 'spaced learning' manual featuring: a literature review; logic model explicating mechanisms of change and implementation data; training guide; and programme content. This manual will be available for use in a future pilot study of the intervention and addressing the key elements of the TIDieR checklist (Hoffman et al, 2014).

Participants

Recruitment will be the responsibility of the project team, with support and assistance from the research team. All schools recruited will be English state schools. None of the schools should be implementing spaced learning, but a range of familiarity with the concept could help with the breadth and depth of feedback on the delivery of the intervention particularly in part 1 of feasibility testing. We will recruit based on EEF preferences that schools have high proportions of pupils eligible for free school meals (FSM), and, as much as possible, are representative of the population of English state schools in terms of Ofsted ratings, GCSE scores, etc.

Randomisation

Randomisation will only occur at the second part of feasibility testing where schools will be randomly assigned to treatments (i.e., spaced learning variants and a business as usual control). This randomisation will occur due to reasons of equipoise and implementation comparison rather than for efficacy testing.

Measures

Outcome measures will only be used during the second part of feasibility testing. For this a bespoke KS3 science attainment outcome measure will be produced. This measure will map onto the content delivered within the spaced learning programme. These measures will be administered pre and post to all pupils in the feasibility study. Furthermore, there will be a bespoke post-test implementation survey administered to all the pupils in the 12 schools.

Sample size

As this is a design and feasibility study there will be no test of efficacy. Therefore, sample size will not be based on required numbers to identify effectiveness rather sample size has been chosen to best suit the service design and feasibility testing process. Therefore, schools have been divided into two sub-samples in the two parts of feasibility testing. Three schools will initially implement a draft version of the programme and its variants. Part 2 of feasibility testing will see 12 schools test the feasibility of refined versions of the programme and its variants. All 15 schools will have all their year 9 classes included in the feasibility tests.

Analysis plan

There will be two parts in the analysis which map onto the two parts of feasibility testing.

After the first part of feasibility testing all group discussions will be audio-recorded and transcribed verbatim and anonymised. Transcripts will be analysed independently by two researchers; transcripts will be read repeatedly, initial codes identified and themes collated and analysed using an 'a priori' thematic 'Framework' method to produce themes relating to perspectives of professionals and young people. This information will then feed into the theoretical framework and logic model. The output of this process will be a refined programme manual.

This second part will see analysis of the pre-post outcome measures and implementation survey. The analysis will explore relationships (correlations) between implementation factors and outcome change. Furthermore, reliability and validity tests of the bespoke measures will be conducted as exploration of the measures as valid, acceptable, intelligible, collectable and showing plausible

positive changes. All measurement data will also be summarised and presented as descriptive statistics providing normative information.

Costs
Cost data will be collected on the following issues:

- Cost of manual & training materials
- Cost of teacher training (including trainer costs and teacher cover)

Ethics and Registration

All research will be conducted according to QUB School of Education Ethical Guidelines. Ethical consent will be obtained from the Ethics Committee before data collection is conducted. Informed consent will be obtained from participants. Once coded and entered onto a database, data will be made anonymous and held securely on a password-protected computer.

No NPD data will be required for this project.

Personnel

QUB – Research Team

LO - Liam O'Hare (Logic modelling & Principal Investigator)
AT - Allen Thurston (Outcome measures & quality control)
CM - Carol McGuinness (Programme materials & training)
AB - Andy Biggart (Qualitative & quantitative analysis)
PS - Patrick Stark (Literature review & research assistance)

Hallam TSA – Practice Team

AG - Alastair Gittner (Practice Team Leader)
PM - Project Manager and Administrator

Risks & Counter Measures

A risk analysis of School of Education and CEE activity has been undertaken. This is presented below by means of establishing the potential risks to the funder and the controls and contingency measures that are in place to minimise these risks. One of the major benefits of EEF funding this proposed evaluation are the extensive and strong controls and contingency measures that The Queen's University of Belfast will be able to provide. This adds security to the funding body and peace of mind that the proposal will be delivered on specification and on-time. Please note that as this study is a design and feasibility study some of the strict requirements around recruitment and attrition familiar in an RCT study are less applicable.

No.	Risks	Current Controls	Net Risk*		Contingency Plans
			I†	L†	
1	Failure of bespoke assessments to collect the required implementation and attainment data	AT has extensive experience of KS3 science assessment and programme implementation. He will produce a bespoke measure linked to curriculum and	5	1	LO CMG have extensive experience in educational measurement, implementation assessment and psychometrics

		relevant implementation measure.			and can improve test reliability and validity if required.
2	Failure to conduct workshops, focus groups and administer assessments at the required time.	RA will notify schools of the time to which we will conduct research. A memorandum of understanding will be completed with all participating schools.	**5**	**2**	Because there is no strict controls in this study. We can recruit additional schools if some drop out.
3	Failure to recruit RA.	CEE have an RA on staff with extensive experience in neuroscience research.	**3**	**1**	In exceptional circumstances, other CEE staff on permanent contracts will be able to visit schools and conduct research.
5	Fire or other damage to electronically-stored data in CEE	Daily back-up of servers is carried out in QUB.	**2**	**1**	Files would be restored and any lost electronic data would be retrieved directly from QUB servers
6	Temporary loss of key project staff due to illness	CEE employs 17 full-time and dozens of part-time 'field worker' staff including administrators, technical staff who are familiar with supporting schools to administer assessments. There are several senior staff in the project. In the unlikely event of illness these staff could fulfil the role of the other. The School of Education at QUB employs a similar number of staff and has very experienced researchers who could provide temporary cover for staff.	**1**	**2**	Other members of the CEE team who are not working on this project would be recruited along with others in their respective departments with the necessary skills and experience
7	Permanent loss of key project staff	See 6. Whilst a temporary solution would be put in place, a recruitment process would follow.	**1**	**2**	Other members of the CEE team who are not working on this project would be recruited along with others in their respective departments with the necessary skills and experience
8	Failure to obtain informed consent from schools	The bid will receive ethical permission from the School of Education Ethics	**2**	**1**	Meetings with schools would be held to reassure them of the nature

		Committee, which will scrutinise practices. The nature and purpose of data collection will be explained schools in advance of their recruitment to the project. Clear participant information sheets will be provided early on in the project to all potential participants. The data collection methods have been utilised in a number of previous projects without the materialisation of this potential risk as an actual problem.			and purpose of data collection.
9	Research assistant does not have appropriate skills set to carry out work/behaves inappropriately in school.	CEE follows QUB best practice on recruitment i.e., References are thoroughly checked. Criminal record background of the applicant are checked with advanced disclosure.	**4**	**1**	All candidates are thoroughly screened before offers of employment are made.
1 0	Control schools decide they no longer want to be part of the evaluation after randomisation.	Clear information will be given to all schools about control condition. Again, there is possibility to recruit replacement schools.	**1**	**2**	Other incentives could be offered after discussion with EEF.
11	Differential of student attrition over conditions.	Due to the nature of this project this is one of the things that will be explored and is useful for future efficacy research.	**1**	**2**	Thought may be given to how to deal with missing data in the final analysis.

† = I is Impact L is Likelihood (5=high; 1=low)

TIMELINE

Date	Phase	Activity	Responsibilities
2015			
Jan	Set-up	• Ethics application QUB school of Education • Collect information for literature review • Finalise job descriptions for Project Manager and Admin Assistant • Start recruitment of three initial 'test' schools • Finalise schools Memorandum of Understanding • Advertise for positions • Plan and book Retreat	QUB Relevant literature to be forwarded to LOH (All) Hallam TSA Hallam TSA Hallam TSA Hallam TSA QUB and AG
Feb	Theoretical	• Structured literature review (around elements of a	QUB + AG

	development	logic model) looking at spaced learning from both a neuro-scientific, lab based cognitive psychology and spaced learning in practice perspectives. • Interview and appoint Project team at Hallam TSA	 Hallam TSA
Mar		*Design initial Logic Model(s)* Program Development retreat Agenda • Capacity building on logic modelling (QUB) • Lit Review Presentation (QUB) • Current practice (Hallam TSA) • *Discuss 'business as usual' control* • Finalise 3 lead schools • Recruit 12 schools for feasibility trial[1]	Group Work (All & including Heads of science from schools). Hallam TSA Hallam TSA [2]
Apr/May		Group of teachers will work with the project team to develop activities, PowerPoints, training, and lesson plans • Draft Training Manual	Led by Hallam TSA (with Science Teachers) Input from QUB Hallam TSA & QUB
Jun	Feasibility part 1	• Training in the three test schools.	Hallam TSA Hallam TSA & QUB
July/Aug		• Reflect on the quality of the materials, whether or not they are useful and engaging, etc. • Review Manual including: lit review; logic model; training manual; and delivery materials	Hallam TSA & QUB
Sep		Trial pilot with 3 schools with X number of programme approaches	Hallam TSA
Oct		• Trial pilot with 3 schools with X number of programme approaches • Develop bespoke science test possibly based on past GCSE science papers (2 versions) • Develop implementation survey	Hallam TSA QUB QUB
Nov		• Implementation survey • Conduct 'Future Workshops'	QUB (teachers & pupils)
Dec		• Analyse data • Review logic models and materials based on pilot	QUB QUB & Hallam TSA
2016			
Jan	Feasibility part 2	Pre-test in 12 feasibility schools - Bespoke science test	QUB
Feb		Feasibility trials in 12 schools (comparison of programme versions N=?[3] with pure control)	Hallam TSA, QUB & Schools
Mar		Feasibility trials in 12 schools (comparison of programme versions N=? with pure control)	Hallam TSA, QUB & Schools

[1] Recruitment will be the responsibility of the project team, with support and assistance from the evaluators. All schools recruited will be English state schools. None of the schools should be implementing spaced learning, but a range of familiarity with the concept help with the breadth and depth of feedback on the delivery of the intervention. EEF would prefer if the schools had high proportions of pupils eligible for free school meals (FSM), and, as much as possible, represented the population of English state schools in terms of Ofsted ratings, GCSE scores, etc.

[2] Note this has moved forward, schools will be better placed if they know this before the end of term, as it may need to be considered when timetabling

[3] Will depend on number of programme variants. For example if there are two variants then there will be 4 schools in each condition, i.e., 4 variant 1; 4 variant 2; and 4 control schools.

Apr		Post-test measures - Bespoke science test[4] & Implementation measure	QUB
May		Analyse feasibility data	QUB
Jun	Review & Finalise	Present final data	QUB
July		• Revise Programme Manual (including literature review; logic model; training manual; and delivery materials) • Programme Manual Graphic Design	QUB & Hallam TSA Outsourced
Aug		Finalise programme manual and submit to EEF	QUB & Hallam TSA

[4] Noting that this is a short time after the end of the delivery of the intervention, and that some of the variation in the delivery of spaced learning may also be relative to the time before the testing

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