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Self-Paced Learning: Effective Technology-Supported Formative Assessment

Report on Achievement Findings

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Introduction

A great deal of research has established that providing frequent formative feedback, to give both the teacher and the pupils themselves immediate indicators of pupils' current levels of understanding and that of the class as a whole, can have a substantial impact on pupil learning. Studies in the UK (e.g., Black & Wiliam, 1998) and the US (e.g., 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, 1995).

In recent years, new handheld learning technologies have begun to help teachers improve their use of formative assessments. These learner response devices enable students to indicate answers to questions posed by the teacher and give teachers (and students) immediate feedback on the performance of individuals or classes. A study conducted with university students indicated that using handheld learner response devices improved learning more than non-technological formative assessment strategies (Mayer et al., 2009). Up until recently, handheld devices have typically displayed questions on an interactive whiteboard and the whole class had to respond to each question before the class proceeded to the next question. However, a new development in the use of learner response devices 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, improving their learning. In this self-paced learning innovation (SPL), questions are delivered to pupils on the screen of their learner response device. As soon as they answer a question, the next one appears on the screen. An evolving graph showing how each child is answering each question and depicting the rate at which they are responding immediately appears on the teacher's computer.

The SPL strategy 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 go back and re-teach to the whole class or a small group the concepts or skills they have missed or do not understand.

Researchers at the Institute for Effective Education at the University of York conducted a small-scale randomised evaluation of the self-paced learning strategy (SPL) to determine if this form of technology–supported formative feedback increases pupil learning. Seven primary schools in the North of England were randomly assigned to use SPL in their Year 5 classes alongside Learning Clip, a mathematics programme delivered on the interactive whiteboard, or to use Learning Clip without the self-paced element (control group) for a 12-week trial period during the Spring and Summer terms, 2011.

This study aimed to provide information about the effectiveness of SPL and about teachers' and pupils' perceptions of using the strategy to learn mathematics. This paper reports on the pupils' achievement results.

Method

Recruitment and assignment

Maths advisers in two local education authorities (Education Bradford and Warrington), who had working knowledge of local schools, provided a list of prospective schools interested in taking part in the evaluation. The schools were invited to attend an information meeting at venues in both localities. It was agreed with the schools that a free Learning Clip subscription and sets of ActivExpression wireless handsets (from Promethean Technologies) would be given to schools whose Year 5 teachers agreed to fully take part in the study and be randomly assigned to the SPL or Control conditions for the duration of the 12-week experiment.

Seven schools were recruited to participate in the study and contracted to undertake the following:

- Oversee the completion of the IEE pre- and post-tests by all Year 5 pupils within the timeframe and conditions specified by IEE;
- Teach lessons using appropriate Learning Clip resources throughout the term of the research project to cover the agreed learning objectives;
- If randomly selected as one of the schools that would be using the Learner Response Handsets, to use the SPL regularly with the learner response devices.
- Provide access to technical support staff in order that the software and equipment could be installed and used throughout the term of the research.
- Notify IEE if there were any support or operational issues getting in the way of using the software or equipment.
- Agree to participation of all Year 5 classes in the research.
- Accept that IEE via Learning Clip would have access to the online usage data as part of the research.

The participating schools and classes were randomly assigned to experimental (4 schools) or control (3 schools) conditions. Teachers of both groups participated in 2-hour training in Learning Clip and the SPL group also received an after-school training on the use of SPL prior to the start of the implementation period. Each of the schools had one Year 5 class, except one control school, which had 2, making 4 classes for each condition. There were 221 pupils in total, 109 in the experimental condition and 112 in the control condition. Control schools were trained to use SPL after the experiment was finished.

Achievement measures

Equivalent pre- and post-tests were devised by the IEE, based on the mathematical learning objectives for Year 5 identified in the National Framework for Mathematics and reflecting the Year 5 lesson content addressed by the Learning Clip units for the Spring and Summer

terms, covering the implementation period. Equivalence was obtained by devising parallel questions and randomly allocating one question to the pre-test and the other to the post-test. The pre-tests were piloted for suitability of content, difficulty level, and timing with Year 5 pupils in a non-participating school. These were paper and pencil tests that were not biased in favour of either condition, because all classes were studying identical content. All pupils in the participating schools were pre-tested before the start of the implementation period on 21 March and post-tested after implementation finished on 10 June.

Training and technical support

Training and support in Learning Clip and SPL using ActiveExpression learner response devices was delivered by Learning Clip personnel to groups of teachers in their locality and reinforced by ongoing support through visits, email and telephone contact.

Technical support included the following:

- Pre-registration of all handsets so the devices were ready to use;
- Labels attached to the back of each device with unique names so that teachers could quickly and easily allocate handsets to pupils;
- Providing and attaching the naming convention for the devices, using the names of animals for allocation to pupils;
- Ensuring that the same handset was used by the same pupil throughout the study;
- Providing an installation check list with guidance and links for schools covering classroom equipment, learner response equipment, and Learning Clip set up.

In line with research findings on the importance of ongoing support for effective programme implementation, teachers were supported in their implementation of the Learning Clip programme and the SPL throughout the study.

Perception measures and observations

In addition to the pre-tests and post-tests completed by the pupils in all schools, teachers completed a survey relating either to self-paced learning (experimental group) or to Learning Clip only (control group). Similarly, pupils completed a short survey relating either to self-paced learning or to Learning Clip only. Both sets of survey questions were in the form of rating scales and open-ended questions. Access to the online usage data provided a statistical profile of programme use.

Over the implementation period, 2 lesson observations were made by the researchers for each class in the experimental group, and one for each class in the control group. Analyses of the teacher and pupil perceptions and observation data will be reported in the final report.

Analyses

Achievement data were analysed using analysis of covariance (ANCOVA). Condition was the independent variable and the mathematics post-test was the dependent measure. The mathematics pre-test was used as the covariate to adjust for any initial differences between the treatment and control groups.

Results

Achievement findings

Results of the analyses showed no statistically significant difference between pupils' scores at pre-test. However, the ANCOVA revealed a statistically significant difference between post-test scores (See Table 1), with effect size = +.39.

Table 1 – ANCOVA

		Pre-test				Post-test - Unadjusted		Post-test Adjusted		
Condition	N	Mean	SD	Sig	ES	Mean	SD	Mean	Sig	ES
Experimental	109	11.29	7.18			14.05	5.29	13.82		
				n.s.	+0.15				p<0.001	+0.39
Control	112	10.54	5.69			11.38	5.74	11.60		

Discussion of Achievement Findings

The achievement findings from this study indicate the potential for technology-supported formative assessment. The results of the statistical analysis show a significant advantage of self-paced learning with Learning Clip interactive whiteboard curriculum in comparison to the Learning Clip programme alone in promoting Year 5 pupils mathematics learning. The analysis produced an effect size of +0.39, which in educational research represents a strong effect. If these findings held over a year it would be equivalent to children attending school for an additional 3 months.

This was a well-designed study in that the schools were randomly assigned to conditions and the mathematics measure was independent of either implementation condition. However, it was a relatively small study with only 7 schools in each condition, and the treatment duration was only 12 weeks. It would be reasonable to expect that, with the strength of the effect found, SPL is likely to promote significant gains in pupils' mathematical learning. Further research is needed on this strategy both to increase the sample of schools and the treatment duration in mathematics and to determine if the effects generalise to other subjects and other year levels.

Online usage data revealed that level of use of both SPL and Learning Clip was less than had been expected. Lower than expected levels of implementation in part reflected the disruption to curriculum time and teaching schedules by statutory holidays during the implementation period. It may be that because the teachers in the study had not used electronic response devices previously they were not used to incorporating them into their daily teaching. The level of implementation in the study may also reflect the usual pattern of learner response device usage in schools. It isn't possible to determine from this study but it suggests the importance of conducting a trial that includes experienced users of electronic response devices.

To summarise, analyses of the achievement data from this relatively small evaluation indicate significant potential for technology-supported self-paced learning to increase primary children's mathematics achievement.

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