Technology-supported literacy and numeracy enhancement workshops for trainee teachers

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Abstract
The paper presents a group-based approach to literacy and numeracy support for trainee teachers who are at risk of not meeting prescribed literacy or numeracy targets. The aim is to develop a pedagogically efficient approach to maintaining and, where appropriate, raising the standard of literacy and numeracy. An audience response system ('clickers') is used to create a pedagogically productive and time-efficient activity workshop. This builds on an earlier project where we developed the respond-discuss-reveal (RDR) technique for increasing engagement in degree level mathematics classes. In this current project the technique is applied to the problem of enhancing literacy and numeracy. The project produces some important results for our approach and leads us to identify a new teaching method named Dialogical Assessment. The project is relevant to the renewed emphasis on literacy and numeracy in Welsh initial teacher training and which has created new statutory duties for teacher training providers.

Keywords
Technology enhanced teaching; literacy; numeracy; audience response systems; formative assessment; teacher education; questioning; dialogic assessment; RDR.

Background and Context
Current Welsh education policy sees a renewed and strategic emphasis on the enhancement of literacy and numeracy across all phases of formal education for school students and for teachers themselves. While Estyn (Her Majesty's Inspectorate for Education and Training in Wales, 2013) present a generally positive picture of the standards of literacy and numeracy in education up to Further Education level, there remains room for continued improvement, including within initial teaching training. The Welsh Government has developed a new Literacy and Numeracy Framework for schools which is now at the implementation stage (Welsh Government, 2013) and which includes national tests in literacy and numeracy up to Key Stage 3.

While there has been measurable improvement in literacy levels across the adult working-age population in Wales since 2001, young school leavers are still found wanting in literacy and numeracy in their transition into work (Welsh Government, 2010). In the workplace, the Essential Skills programme, an ESF (European Social Fund) funded project ending in 2015, aims to improve '… the ability to read, write and speak in English or Welsh, and to use mathematics, at a level necessary to function and progress both in work and society" (Welsh Government, 2012a). Similarly therefore, a transition into further and higher education for many young people can be challenging if their literacy and numeracy capability is not commensurate with the demands of degree level study or professional training.

In initial teacher training this strategic focus imposes a statutory duty on training providers to ensure, through testing, more reliable literacy and numeracy outcomes (Welsh Government, 2012b) in order to strengthen the basic literacy and numeracy skills of newly qualified teachers. From September 2013

all providers in Wales will be required to assess entrants as having adequate functional skills in literacy and numeracy appropriate to a professional teaching context and to ensure that this standard is maintained, if not enhanced, throughout the training programme.

In this paper we build on our previous research projects (Green et al., 2009; Longman and Green, 2011; Green and Longman, 2012a; Green and Longman, 2012b) where we have developed computer-supported tools and practices that have enabled us to evaluate student literacy and numeracy against a purpose-designed audit tool. More recently we have been encouraged by the constructive effect on group learning afforded by the structured use of an electronic voting or audience response system (clickers') (Green and Longman, 2012b) which is defined as follows:

> 'An audience response system (ARS) has been praised as an effective teaching tool, primarily because it transforms a lecture into an interactive learning experience. With this system, each participant in the audience registers a response on a key pad, and the responses are instantly tallied and displayed on screen'
>
> (Latessa and Mouw, 2011; see Longman and Green, 2011).

A key issue arising from our earlier work on evaluating undergraduate literacy or numeracy using online audit tools was that whereas the initial stage of measuring the literacy and numeracy capability of an individual can be quick and informative, the follow-up stage of remediation or enhancement is more time intensive, and mostly relies on individual and independent working. For busy students training to be teachers, the consequences of a weak score in a literacy or numeracy audit can lead to an increased workload and while good learning support services are generally provided within universities, these may not always meet the specific needs of individuals.

In our previous work we found that the use of clickers using a '*respond-discuss-reveal*' (RDR) approach to the use of multiple choice questions can enhance some important characteristics of effective learning. This includes the confidence to be wrong, particularly in a group setting, and the explicit construction of 'thinking time' as an element of problem-solving. The use of this relatively simple tool thus enhanced perceptibly the engagement and participation of the students by directly affecting the manner in which they were encouraged to reflect upon their responses.

Respond-Discuss-Reveal

| Display question |
| Wait for all student |
| Display graph of |
| Group discussion |
| Reveal correct choice |

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Figure 1: Illustrating a handheld clicker and the RDR procedure flow-chart.

In this current project we aimed to apply the use of this technique to the rather different situation of specific literacy and numeracy enhancement sessions targeted at those undergraduates who, on first sitting our in-house audits as part of the School of Education's Professional Development Planning (PDP) process, are identified as in need of support for improving aspects of their literacy and numeracy. As noted, however, explicit target setting for literacy and numeracy development can be challenging for students and for tutors alike, particularly in relation to the subsequent actions that a student might need to undertake in order to meet a target or targets which have usually been articulated as an outcome of the supported PDP process.

Ultimately this project is looking ahead to the forthcoming requirement in Wales for teacher training providers to test student teachers on entry for their levels of literacy and numeracy and subsequently to be accountable for their standard of literacy and numeracy when they are finally awarded Qualified Teacher Status (QTS). In this context we aspire to adopt an approach that is both efficient in relation to student workload and constructive in terms of learning outcomes. Already, UCET (Universities' Council for the Education of Teachers) Cymru is engaged in examining the possibility of adopting an all-Wales approach to the initial testing of entrants (a requirement that is over and above the new entry requirement of a minimum GCSE grade B in English and Mathematics) and it is our concern to further this work by exploring techniques that might assist the continuous monitoring of literacy and numeracy standards throughout a training programme.

Method

The simple organisational strategy for this project was to provide group-based opportunities where students would benefit from the cognitive and affective boost that was described in our previous clickers' project (Green and Longman, 2012b). These include the confidence to be wrong and the confidence to engage in open-ended discussion and explanation of the underlying reasons for the acceptable or unacceptable facets of literacy and numeracy knowledge. Through this approach we expected to see improvements in literacy and numeracy knowledge and ultimately in outcome scores on literacy and numeracy tests.

A small sample of participants was selected using the results of our own in-house literacy and numeracy audits that students complete soon after commencing the course in the Autumn term. Two sessions each in literacy and numeracy were then conducted using items sampled and adapted from the original audits and converted into RDR-style PowerPoint shows (as described in Green and Longman, 2012b). Ten questions were created for each of the initial numeracy sessions and fifteen questions for each of the literacy sessions. A final joint session was conducted aimed at providing simple summary data for all participants and a simple semi-structured survey was used to capture any commentary feedback that the participants felt able to provide.

It should be emphasised that the context of this project is somewhat different from that of much of the research conducted on the use of clickers in higher education. Our use of RDR is aimed at developing a reflective approach to learning in the domain of functional numeracy and literacy. Whereas much research, typified for example by Caldwell (2007), Retkute (2009) or Stowell and Nelson (2007), demonstrates improvements to learning outcomes, these are usually studies that compare the effect of clickers with 'traditional' teaching methods. In the context of teacher training, encouraging an approach to learning which is reflective and self-aware is central to notions about professional development (Scales, 2012). The focus of this project therefore is on the potential of

clickers for enabling a safe and reflective approach to improving skills in literacy and numeracy as much as it is on the direct improvement of test scores.

The participants were initially selected on the basis of a score of 64% or less in either the literacy or numeracy audit (see Table 1.). This criterion was purely pragmatic in that for the purposes of this experiment it provided manageable group sizes while targeting students at the lower end of the test scores. A total of 21 students were selected and all agreed initially to participate but a number of factors reduced the participation to 6 each from the literacy and numeracy groups (with one student a member of both).

Table 1.: Initial samples: <65% in audit in any of 3 sections of each audit (n=33).
ID codes: 'L' denotes a student in the literacy group and 'N' denotes a student in the numeracy group. 5 students appear in both groups.

Literacy Sample

Lexical

ID	Score/27	%
L3	15	56%
L4	15	56%
L5	17	63%
L9/N7	14	52%
L10	17	63%

Grammatical

ID	Score/40	%
L1/N1	25	63%
L2	22	55%
L7/N5	23	58%
L8	23	58%
L9/N7	16	40%
L10	25	63%

Punctuation

ID	Score (vrble)	%
L6	33	37%
L11	51	63%
L12/N10	53	61%

Numeracy Sample

Shape, Space, Measure

ID	Score/18	%
N1/L1	11	61%
N4	11	61%
N5/L7	11	61%
N7/L9	11	61%
N8	11	61%

Number

ID	Score/23	%
N2	14	61%
N10/L12	14	61%

Data handling

ID	Score/14e	%
N3	9/14	64%
N9	9/14	64%
N10/L12	9/14	64%

As noted later in the concluding discussion, the data generated by online tools such as the in-house audits as well as the clicker software can provide information in at least two dimensions: 'horizontally' to show the scores for an individual student (allowing for an identification of specific items that proved challenging) and 'vertically' to show a cohort level response to items. Such feedback allows for the calibration of audit items (which will be the focus of a further project planned for next year) and also, where required, to calibrate support for individuals and groups in specific areas.

Thus, for example in the literacy audit, subsection 'Grammar', student L9 scored a somewhat low 40% across the eleven items in this section. In addition, the entire cohort of thirty three students fell well below the boundary score for items 3 and 8 in that section of the audit (an average of 41% and 44% respectively) and for two further items only scored an average of 61%. Thus while the boundary score was used to select individuals for the pilot project, it might also have been used at the cohort level to identify items for which more universal support was needed. By contrast, item 9 scored a massive

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average of 93% across the whole cohort suggesting either that the specific element of grammatical knowledge tested is secure or that the item is not a good test of knowledge for that grammatical concept.

Similar patterns can be discerned in the numeracy audit. For example, in 'Shape, Space and Measure' although the selected group scored 61% overall, the cohort as a whole scored less than 60% for items 2, 3, 4, 6, and 16 thus indicating that these particular items were either too challenging or insecurely understood by just over half the cohort.

The procedure followed for the enhancement sessions was a straightforward replication of the RDR-style developed in Green and Longman (2012). This consists simply of a presentation of a question or problem with a multiple-choice set of responses. Students consider the question and respond using the clicker. Next, the bar chart of results is displayed – this shows the responses for an item and might typically show a distribution of selected options. A brief discussion ensues in which students are asked to explain or justify why some responses have been selected and why some have been avoided. Finally, the correct response is revealed and discussion ensues. As explained in our previous paper, learning really develops in the discussion sequence where, in a supportive and peer-oriented environment, confidence in the use of appropriate language is developed.

Results

The response data was collated and anonymised to produce the summary tables illustrated in Table 2. These show the headline results for each of the literacy and numeracy support sessions and the summative final session where students were simply asked to respond to one each of a literacy and numeracy audit without discussion. They also responded to an online survey in order to provide some general feedback comments on the extent to which they found the sessions valuable. The final session was a mixed group of six students, three from the literacy sample, two from the numeracy and one who was a member of both samples. All students in this final session responded to both the numeracy and the literacy questions.

The sample sizes are of course very small and attendance was patchy rendering the final results unreliable in a useful numerical sense. However, we can focus on the individual cases to reinforce our main point that the simple score, or measurement, taken at point A in the Autumn term turns out not to be a reliable predictor of the score at Point B. It is also important to note that the conditions under which the data were collected was very different in each case: at Point A the score is derived from a straightforward online audit but at point B involved interactivity and discussion.

Table 2. Final results: RDR scores for Sessions 1 & 2 and joint final session
Literacy sample = 6 students. Numeracy sample = 6 students. (1 student in both groups).

Literacy		Session 1 (15 qu)		Session 2 (15 qu)		Session 3 (16 qu)	
ID	Audit	Score	%age	Score	%age	Score	%age
L2	55%	**12**	**80%**				
L3	56%	8	53%	8	53%		
L4	56%	**10**	**67%**	8	53%	**12**	**75%**
L5	63%	7	47%	8	53%	10	63%
L9/N7	46%						
L10	63%	*7*	*47%*	**10**	**67%**		
N3	73%					*9*	*56%*
N9	74%					*7*	*44%*

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Bold	Score improved beyond threshold
	Score improved but below threshold
Plain	No significant change
Italic	Score declined

Numeracy		Session 1 (9 qu)		Session 2 (5 qu)		Session 3 (8 qu)	
ID	Audit	Score	%age	Score	%age	Score	%age
N1	61%	*5*	*56%*				
N2	*61%*	*5*	*56%*				
N3	64%	**6**	**67%**	**5**	**100%**	5	63%
N4	61%			3	60%		
N5	61%	**6**	**67%**				
L9/N7	61%					*4*	*50%*
N9	64%	**6**	**67%**	*2*	*40%*	**6**	**75%**
N10	64%	**6**	**67%**	3	60%		
L2	83%					*3*	*38%*
L4	75%					*3*	*38%*
L5	72%					*2*	*25%*

There were only a small number of cases where students completed all three sessions – only four in literacy and only two in numeracy completed all three sessions - and as explained in the previous section there were some drop outs or non-attendance. Nevertheless, the variation in these results is interesting and this has led us to consider more carefully the underlying issues in what it means to monitor, maintain or strengthen literacy and numeracy.

There are four categories of change in these tables: those that have 'improved' beyond the original threshold score (i.e. >64%), those that have improved but have not reached the threshold, those that
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have declined significantly (by 5% or more), and those that, while dropping very few percentage points are regarded as no change.

There are some striking patterns. When we look at the **numeracy results** for the final session it is noteworthy that the three members of the literacy sample (L2, L4, L5) have produced particularly low scores in numeracy even though they were *not* selected for numeracy support because their initial numeracy scores were above the 64% threshold. A similar pattern, equally striking, is evident in the **literacy table** where the scores produced by the numeracy sample (N3, N9) who were *not* selected to participate in the literacy group are equally disappointing.

It would seem that the initial scores could not be taken to be reliable indicators of consistent performance between the first audit and the check-up in the final session. It should be remembered, too, that the items used through the session were identical in form and level of challenge to those used in the original audit thus rendering this outcome more worrying.

The pattern of scores across the literacy results are a little more encouraging. Of the four cases who took part in all three sessions three showed a marginal improvement (L2, L5, L9) and one showed a dramatic improvement (L4). Of the remaining two cases one showed an improvement (L10) and one no change (L3).

Similarly, for the numeracy scores; of the two cases that completed all three sessions one showed no change (N3) and one showed marked improvement (N9). Case N3 showed a dramatic improvement in session 2 but it should be noted that for that session there were only five questions used as the time spent on discussion was considerably longer leaving less time for responses to specific questions. Case L9, who was also a member of the literacy group, showed a decline in the final check-up session but did not attend the first two numeracy sessions. The remaining numeracy cases are generally sound for the first session where slight improvements are indicated although the result for N10 indicates that this might not be reliable because in session two a marginal decline in outcome was measured.

Survey feedback

As part of the final session, an online semi-structured survey invited responses to questions about the effect of the activity on students' levels of confidence and understanding with respect to literacy and numeracy knowledge. We recognise that there is a problematic relationship between self-perceptions of learning and measures of 'actual' learning (as highlighted yet again by a recent study reported in Times Higher Education (2013)) but this issue is not discussed here. Indeed, it may be as important for trainee teachers to learn that the practical aspects of literacy and numeracy are susceptible to discussion as a means to improvement as it is for them to acquire a set of production skills. Thus the use of a self-report survey is considered to be of intrinsic value to the overall pedagogical purpose of the project.

Some comments from our respondents underline the difficulty of definition, the problematic nature of diagnostic testing and, in one case, the process did apparently undermine confidence:

> *'While I felt more relaxed about getting the right or wrong answer I have not felt more confident about the topic.'*

'I have always known that my literacy is weaker than my numeracy yet numeracy was flagged up for me as something that I needed to improve. My literacy is still weak (spelling and punctuation in particular) and my numeracy will only improve further with further self study.'

'I lost some confidence in my understanding of literacy [particularly with my spelling]*.'*

Our respondents generally reported that they already felt confident in discussing the topics or that the format of the enhancement sessions worked well for them:

'By the time I attended the clickers session my confidence had increased as I had already sought to understand certain maths tasks that I was experiencing difficulty with. I thought the group discussion format worked well.'

'Being able to discuss through the answers and the reasons why we were getting the wrong answers greatly helped with the confidence of getting wrong answers. I felt that getting the wrong answer was good in these sessions to see WHY I was getting it wrong.'

'I was happier to give answers and certainly initially to build the confidence in order to give answers relating to literacy.'

'The use of clickers was good because it helped us to be able to see who thought what during the session and enable discussions. It was also a help to have people there to discuss with rather than being on your own at home .'

The group size and the social aspects helped in some cases:

'Felt more relaxed as the group was a lot smaller than normal. Although I have never been one to shy away even when giving the wrong answer.'

'In addition to highlighting areas … it helped me to realise that … there is more than just me with areas that need serious revisiting. '

The clickers seemed to be a positive use of technology for some although as with all such tools, there are unfamiliar aspects that take some getting used to:

'…the sessions were so much more visual, and the kinaesthetic aspect was a boost. I felt like I had a direct contact with the words and phrases, which gave me the impression that I was physically picking and choosing my answers.'

'…the use of clickers was helpful as answers were giving anonymously. This allowed me to feel confident to give my answer and then decide if I wanted to discuss it afterwards.

I did find that I had 'accidentally' clicked on one wrong answer and another answer (which was correct) appears not to have been recorded on the printout.'

'I had to be confident with my answer before clicking otherwise no chance to go back and change .'

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Finally, the value of the discussion element of the session seems to have had the greatest effect on the perception of learning, even if the scores presented in the previous section do not indicate a strong level of actual learning:

> '… more so during the … discussions. For example, my understanding of the use of apostrophes was enhanced.'

> 'By discussing it allowed me to gain a better understanding of the reasons I was wrong on certain questions.'

> 'It was good to show the divided opinion amongst answers. With the answers being discussed it made it more understandable why certain things should or shouldn't be.'

> '[it] helped to be able to discuss through incorrect and correct methods of how to answer particular questions. A few questions I got wrong all the time and was unsure why so the discussions were helpful to see why.'

Discussion

In this project we set out to develop a straightforward way in which we could provide enhancement workshops to small groups of student teachers who had been identified to be in need of additional development in literacy and/or numeracy.

Our initial thinking had four starting points: (i) in the Welsh context, new external obligations are placed upon teacher training providers to test and monitor a requisite level of literacy and numeracy for both recruitment and the award of QTS; (ii) the success of our previous project demonstrated that, when used in a particular way, the clickers helped to produce higher levels of engagement, enthusiasm and thinking (the RDR method); (iii) the current method of target setting by students on the basis of their initial audit results was not proving satisfactory; (iv) our experiment should aim to promote, through RDR, active critical reflection on those audit items where students would normally set targets.

A fifth aim was that our experiment, if successful, should be seen to visibly improve literacy and numeracy by pedagogically efficient means, i.e. raising standards for target groups of students using small, highly structured RDR workshops instead of target setting. More broadly, we were motivated by the usual concerns: to develop a manageable, measurable and scalable method for monitoring and improving standards. Above all, the classroom experience that we designed for the participating students should be an enjoyable and positive experience for them, one where the value of participation is as visible to them as it is to us.

The fact that we were surprised by our results helped to reveal some important assumptions that we were holding about the 'learning path' that we expected our students to follow. Our numerical results showed that some of these assumptions cannot be upheld. First, we incorrectly assumed that the initial testing provided by our initial training programme provided us with a reliable and stable measure of capability; second, we incorrectly assumed that we would arrive at a consistent outcome, one which of course we hoped would be positive.

As a matter of scientific procedure, therefore, our experiment was sufficiently biased by these expectations to make our data seem disappointing. We certainly hoped for a set of raised scores, and

at worst we thought we could be satisfied with scores that, overall and for the sake of a consistent result, had fallen. It would seem that a simple improvement in scores can neither be guaranteed nor can it necessarily be taken to be an indicator of maintaining or improving a standard. The exposure of these assumptions has led to an improvement in our methodological thinking.

On reflection, our diverse and contradictory numerical results are only to be expected. On closer inspection our data, taken overall, demonstrates that our outcome scores are consistent with the initial scores within a reasonable margin of error, so we are at least maintaining standards with only a very small number of participants losing even a small amount of ground.

Our main problem with this particular experiment, however, is that we are not apparently raising the standard for this group of participants who had been selected for their initial below par score. Against this we need to see that this was a pilot and that a future implementation would be engineered to provide a more organised and extended approach perhaps by embedding support sessions within the normal timetable.

A third, more tacit assumption that underlay our design was our belief in the value of the RDR method. This assumption was not contradicted by our outcomes. The value of this method, which is essentially dialogical in nature, is borne out by the written survey comments from the students. Participation is clearly a positive experience for the students and their comments strongly suggest that their participation had value for them in several important dimensions of learning: confidence in sharing weaknesses as well as strengths; the use of structured tools to focus the activity; the oralisation and articulation of literacy or numeracy ideas and facts. However, although this assumption of the value of the RDR method was not contradicted, for future applications of the method we would want to focus a little more on the difference between perceived learning (as reflected in the comments) and actual learning (as might be measured by numerical scores).

Conclusion

In this project we did not aim to develop merely instrumental tools that, through direct testing, can demonstrate either no change from an acceptable baseline or quantitative improvement. Our problem is more pedagogical in nature: how can we build a focussed, supportive and developmental approach to literacy and numeracy for teachers-in-training where testing and the attainment scores are not an end in themselves but form part of a participatory process embedded and hopefully internalised in their professional development. Our experiment has been successful in achieving this end to some degree. Importantly, it has also led us to refine our thinking about our methodological approach which we aim to develop in future projects and which we have named 'Dialogical Assessment'.

This name simply highlights the importance of two features in our project design that we hope to develop and which form the foundation for a model of learning and development that is well matched to the needs and circumstances of initial teacher training students who, of course, are also adult learners:

(i)   The central role of group discussion as a tool for clarifying understanding and knowledge
(ii)   An efficient use of structure and time which provides a clear framework to the trainee teacher

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However, we have yet to fully manage the issue of the variability of measured performance over time. This is a particular problem if we are to rely on the initial diagnostic identification of individuals who fall at or below a relatively arbitrary initial test score. Providers will need to offer some sort of confidence measure of a trainee's literacy and numeracy capability before they can be awarded qualified teacher status. The Dialogical Assessment approach we are developing here is based on the idea that building personal reflection and fluency about literacy and numeracy through ongoing dialogue is a potentially strong way to promote the emergence of an intrinsically held approach to professional development by trainee teachers.

Related future developments are already under way in Wales. UCET Cymru, a representative group of all Welsh training providers, is working towards a single all-Wales approach to an initial assessment of literacy and numeracy at the recruitment stage. Our work on this and other projects is contributing to these developments which provide a good opportunity to apply some of our methods not only at a local level but at a more strategic national level too.

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