What's changed? Issues of impact and evaluation in primary science professional development

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Abstract

This article reports on issues arising from the external evaluation of a teacher development project – the Active Learning in Primary Science (ALPS) project – undertaken in eight Bristol (UK) primary schools during 2007. The ALPS project aimed to raise pupil attainment in science by developing participating teachers' skills, knowledge and enthusiasm through a programme of centre-based CPD, classroom workshops, in-school consultancy and visits to a hands-on science centre. The evaluation used a combination of documentary evidence, pupil performance data, teacher interviews and observations to gain a view of the strengths, weaknesses and impact of the programme. This raised questions concerning the timing of such evaluation studies, the tensions between the agendas of the various stakeholders and the validity of any short-term apparent gains in pupil performance or teacher attitude. The article problematises the current UK government emphasis on 'measuring impact' from CPD activity.

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Introduction

The effectiveness of programmes of continuing professional development (CPD) for teachers has been the subject of much discussion over the past decade or so. Whilst the emphasis before around 1990 might have been placed on the personal development of the individual teacher through 'in-service training', questions concerning the impact of such training on teachers' classroom pedagogy and children's learning have increasingly been asked. In the field of primary science education, Harland and Kinder (1997) have developed a typology of nine kinds of possible outcomes from in-service training, ranking these outcomes in a hierarchy which privileges 'change in practice' as the ultimate goal of such work. Several studies of CPD programmes have since claimed evidence of such change in practice, for example the Partnership in Primary Science (PIPS) project (Rodrigues et al. 2003) which emphasised the importance of starting with teachers' perspectives and giving them ownership of the change process. The complexity of this process of negotiating previous pedagogical conceptions with new ideas and practices is highlighted by Scott and Mouza (2007), whilst Fraser et al. (2007) question the validity of external 'measurement' of an internal, intuitive skill such as teaching. 'Lower order' impacts (in Harland and Kinder's terms) such as increased teacher confidence appear much easier to evidence (Brown et al. 2002), although Glover and Law (1996) questioned how robust such affective outcomes could be seen, given that they were largely self-reported by participants or their managers. Burchell, Dyson and Rees (2002, p 220) argue that teachers' perceptions of their own professional learning are indeed valid, since "…they form the basis on which unique individual patterns of professional learning and development, and potential for impact, can be identified."

However, in the last decade, the emphasis within CPD impact evaluation in the UK has increasingly shifted towards the effect of pedagogical changes upon pupil learning and achievement. This has to a large extent been driven by the UK government focus upon pupil attainment as measured by standardised tests. National programmes of CPD such as that accompanying the implementation of the National Literacy Strategy (DfEE 1998) have been evaluated in terms of their perceived impact upon pupil attainment rather than teacher development (Fraser et al. 2007). The Training and Development Agency (TDA) requires all university-based provision of Postgraduate Professional Development (PPD) to 'have as its main objective the improvement of pupils' performance through the embedded improvement of teachers' knowledge, understanding and practice' (TDA 2007a) and to have built-in evaluation procedures designed to measure such improvement. This followed findings from the Office for Standards in Education (2004. p. 12) that '…fewer than a quarter of providers make any attempt to evaluate the impact on pupils.' Much criticism has been levelled at this approach to programme evaluation. Flecknoe (2000) points out three obvious difficulties: the lack of control groups against which to judge any gains in pupil performance; the difficulty in establishing causal links because of multiple influences on learning; and the 'Hawthorn' effect by which any intervention is likely to raise standards in the short term. Powell and Terrell (2003) reject any quantitative analysis of learning gains as methodologically flawed and a misguided attempt to reduce teaching to a 'technical-rational pursuit', whilst several studies (e.g. Hopkins and Lagerweij 1996, Brown et al. 2002, Piggot-Irvine 2006) have found limited evidence of a causal relationship between CPD provision and learning improvement. Teachers commonly assume that any effect on their teaching would have an impact upon children's learning (Brown et al. 2002, OfSTED 2004) but find it difficult to provide tangible evidence for this belief. Even where a great deal of effort and money has been expended to obtain robust impact data, Flecknoe (2003, p. 133) argues that it would be hard to persuade some colleagues of causality, and that consequently "…it is unrealistic to ask that all programme providers should also be able to provide detailed evidence of impact if this is the sort of evidence that is required." Even the TDA in its review of PPD programmes (TDA 2007b) fell back on 'proxy indicators' of improved pupil performance, such as the appearance of 'engagement' with their work, whilst acknowledging that timescale (i.e. it is too early in many cases to judge the impact on pupil learning experiences) and causality remain problematic.

Evaluating the ALPS Project

Against the background of an increased emphasis on teacher and pupil 'performativity' (Fraser et al, 2007) as measures of the impact of CPD, the Centre for Research in Early Scientific Learning (CRESL) at Bath Spa University was commissioned by the Science Learning Centre South West (SLCSW) to undertake an external evaluation of the Active Learning in Primary Science (ALPS) project in 2007. ALPS was a collaboration between the City of Bristol Local Authority (LA), SLCSW, the At-Bristol hands-on science centre in which SLCSW is located, and two nationally respected primary science consultants. Based on a model piloted in another area of the UK, the project was funded by a £70K grant from Bristol LA and aimed to provide intensive support in science curriculum development to 10 Bristol primary schools through a package of centre-based CPD, school-based workshops with classes of Y5 and Y6 pupils (aged 9-11), visits to At-Bristol and school-based consultancy support. The stated aim of the ALPS project was:

- To improve performance in science in primary schools within the Bristol LA through a combination of professional development and school-based support for teachers

The project was directed at a small sub-set of relatively high attaining schools; the 'improved performance' referred to in the above aim was seen by the commissioning authority in terms increases in pupils achieving the highest National Curriculum level during statutory tests in May 2007, although quantitative targets were not set. Bishop and Denley (2006, p 86) criticised CPD "… directed towards achieving institutional targets determined by external authorities," since they observed that this tended to privilege generic curriculum and assessment above the subject needs of individual teachers. However, in the case of ALPS there was a needs analysis process to identify teachers' self-perceived areas for development in primary science subject knowledge and pedagogy. The project set out to achieve a number of 'intended outcomes' for participants and their pupils:

- To broaden teachers' repertoire of creative teaching and learning approaches in science
- To improve teachers' enthusiasm in teaching science
- To improve teachers' subject knowledge and understanding of science
- To develop opportunities for primary science educators to reflect on their practice and provide opportunities to discuss best practice with colleagues from other schools
- To improve science coordinators' leadership in their schools
- To provide creative activities that will be motivating and interesting for pupils
- To improve pupils' attainment in science

These outcomes align reasonably closely with Harland and Kinder's (1997) hierarchy, with the addition of a focus upon pupil attainment which was not part of Harland and Kinder's model but relates closely to TDA criteria (see above); reflecting the current CPD climate in England although the ALPS project was not itself TDA-funded.

Methodology

Our evaluation adopted a multi-method approach (Saxe and Fine, 1979): "an approach which contains both formative and summative dimensions, which draws on a range of research strategies and techniques, and which generates both qualitative and quantitative data." (Bennet, 2003: 57). Such approaches are now an established feature of programme evaluation research (Clarke 1999), offering a number of associated benefits:

- "They permit exploration of both the outcomes and processes associated with a new programme
- They result in improved and enriched findings, yielding greater understanding of what is happening, why it is happening and how it is happening
- They permit modifications to be made to aspects of the evaluation plan should unanticipated outcomes worthy of further exploration be encountered
- They generate multiple sources of data which provide checks on the validity and trustworthiness of the findings" (Bennett 2003: 59-60)

The evaluation aimed to elicit the perspectives of as many stakeholders as possible and to capture the process as well as outcomes of the project to the extent possible within a largely retrospective study – the ALPS project ran from January to September 2007 and our evaluation was commissioned in July. Although outside the control of the evaluation team, the retrospective nature of the evaluation was problematic, since much of the project activity had already been completed and an evaluation strategy had not been built in at the outset, as recommended by Piggot-Irvine (1006) and TDA (2007). Data collection aimed to triangulate a number of sources and types of data to examine evidence against each of the intended outcomes of the project, as follows:

1. Documentary evidence, including planning documents, minutes of meetings and an internal evaluation report, which included analysis of a range of data collected by the project team, including:
   - Participant evaluation forms following each of four centre-based CPD sessions (n = 40)
   - Focus group interview with participant teachers (n = 6)
   - Group interviews with pupils at end of project 'showcase event' (n = 90)

2. Statistical data for each participating school concerning pupil performance on national tests in science over a period of three years up to 2007.

3. Semi-structured interviews with members of the project team (n = 5) and with headteachers of schools who had withdrawn from the project (n = 2)

4. A pupil survey at the end of project showcase event including five=point Likert-type attitude scales (n = 93)

5. Observations of consultancy support in school and the showcase event

6. Visits to schools remaining in the project as of September 2007 (n = 7) including interviews with headteachers, project participants and other teachers within each school.

Quantitative data pupil performance and survey data were analysed statistically using the Wilcoxon Signed Ranks Test to determine the significance of any changes or shifts in attitude. Qualitative documentary, observation and interview data were synthesised into school case studies and compared under project outcome headings.

Summary of Findings

In the summary below, the seven schools completing the project have been assigned the letters A to G. The majority teacher participants interviewed - both in the focus group and during school visits - agreed that it had been the 'unique combination' of elements within the ALPS project which had impacted upon their subject leadership skills and classroom practice. Benefits from individual elements were identified as follows:

<u>Central CPD training sessions</u>
Session 1 (subject leadership), together with consultancy support, resulted in enhancement of participants' subject leadership skills in taking a more proactive role to lead change (schools E and F), including action planning (schools C and G); monitoring science teaching and attainment (schools C and G); planning and leading staff meetings (schools B, E); and analysis of pupil assessment data (school F). Session 2 (scientific enquiry) together with the school workshops, led to subject knowledge enhancement in the areas of forces (school C) and understanding of scientific enquiry (school B). It also resulted in specific changes in practice for participants, including a greater focus on investigative work (school B); less reliance on writing to record investigations (school B, D); use of planning boards (school D); the clustering of investigative skills (school G); and using 'human bar charts' (schools E, G). Session 3 (assessment for learning), together with consultancy support, resulted in specific changes in school practice, including a critique of existing science assessment (school A); the development of an assessment tracking system (school D); and the use of 'floorbooks' as a means of recording children's understanding (school D). Session 4 (creative approaches, talk

in science), together with workshop sessions, led to subject leaders reporting in the focus group interview that they had made changes to their practice in order to make more use of 'creative' approaches in their science teaching; provide opportunities for students to talk in and discuss science; incorporate "real science" in the classroom; and take a more active approach, using more games (schools C, E, G).

School-based workshops

In addition to the impacts listed above, school-based workshops were effective in communicating enthusiasm about science to pupils, which was seen as a key to exciting the children's interest (school A); providing subject leaders with opportunities to observe the children and make formative assessments (school B); provide subject leaders with new ideas for hands-on, 'real' science (schools C, D). However, some schools (F, G) felt that workshops reinforced rather than led practice, and did not challenge higher attainers. School B questioned the use of what they regarded as 'specialist resources' within workshops, although the project team asserted that all equipment used was of a generic nature.

In-school consultancy support for subject leadership in science

Three schools (A, C and G) mentioned the value of in-school consultancy, to support subject leaders in planning staff meetings and understanding their leadership role (school G). The consultancy session in school A observed as part of the evaluation appeared to be highly effective in shifting the subject leader's approach to assessment.

Visits to At-Bristol hands-on science centre

Although no subject leader attributed impact on their own practice from the visits, the focus group interview and school visits indicate that participating teachers saw visits to At-Bristol as integral to the project in order to increase the 'wow' factor for pupils (supported by pupil interview and survey data); and to take advantage of a visit which they saw as 'normally very expensive' (schools B, D).

End-of project showcase event

The showcase event appears to have made a negligible impact on subject leaders, although it had been enjoyable for pupils (school F). It was felt that not all schools had taken the dissemination responsibility within the event seriously (school D), and observation of the event by the evaluation team suggests that clearer briefing and expectations on the schools could have resulted in a much more significant opportunity for teacher participants to inform each others' practice.

Impact upon pupils

Evidence from pupil interviews, the pupil survey and school visits indicates that pupil attitudes towards science have become significantly more positive through the ALPS project. However, in the absence of baseline data collected at the beginning of the project, data need to be treated with extreme caution, since they refer to pupil's own perceptions of their attitudes before and after ALPS. For the majority of pupils responding to the survey (62/93), an attitude gain of between one and four points on the five-point Likert-type scale used appears to have occurred. To test to see whether such a gain is statistically significant, we first compared the 'negative ranks' (those where pupils reported that their attitudes had become more negative) with the 'positive ranks' and 'ties' as in table 1:

Insert table 1 about here

We then uses the Wilcoxon Signed Ranks Test (designed for non-parametric data) to calculate the significance of this result (table 2):

Insert table 2 about here

The figure of '.000' in table 8 indicates that there is less than a 0.1% chance that the attitude change could have occurred by chance; in other words it is statistically significant within the limitations of the data set. There were

Focus group interviewees and interviews with participant teachers from schools B, C, E, F, G triangulated well with these data, reporting on shifts in pupils' perception of science as a human endeavour, together with increasing motivation and interest in science, citing the enthusiasm of the ALPS team as crucial in this regard. Another aspect teachers mentioned was the development of the children's curiosity and inquisitive natures. There were, however, differences between the participating schools. Applying the Kruskal Wallis Test to the survey data identified by school, pupils from school D appeared to report significantly more positive attitudes towards science than those in schools F and G, both before and after the project. Also, the extent to which pupils viewed science as fun or interesting varied significantly between the schools. So pupils from schools B and D were significantly more likely to report their science as fun and interesting than those from schools F and G. Gender differences also emerged from the statistical analysis, with boys' reported attitudes before the project significantly more positive than girls, although there were no significant differences in the post-project attitudes. We might therefore conclude that the project had a particularly positive impact on girls' attitudes towards science.

Improvements to pupil attainment are less easily evidenced than attitudinal change, particularly over a project period of only four months between project inception and summative tests. From an analysis of national test results in 2006 and 2007, science results at level 4 (the national benchmark at age 11) and above showed modest gains in all schools (above the national average) except school G (which was already the lowest performing) where they fell slightly. The level 5 results (highest attaining at age 11) were more mixed, with sizeable gains and falls distributed roughly equally, though it should be recognised that this represents a very small number of pupils overall. These results would suggest that the ALPS project may have had some impact in moving a small number of pupils from level 3 to level 4 across project schools, but no conclusions can be drawn on its impact on level 5 achievement. From the school visits, other triangulating evidence of project impact on pupil attainment in science is sketchy and anecdotal, for the following reasons:

- The lack of detailed information about pupil performance in science collected before the project;
- The lack of evidence (e.g. samples of work, transcripts of discussions etc.) collected by participating teachers during the project;
- The timing of the evaluation, meaning that school visits were conducted during September 2007, after participating 11-year old pupils had transferred to secondary education;
- The disposal of Y6 science attainment evidence at the end of the academic year 2006-7 by participating teachers, despite the request in a letter sent to schools by the evaluation team in July 2007 asking them to retain such evidence.

Teachers reported improvement in science knowledge and scientific skills (school B); asking more scientific questions (school C); and demonstrating more confidence in expressing scientific ideas and discussing investigations (school G), although as noted by Brown et al. (2002) this was largely a matter of belief unsupported by rigorous evidence.

Discussion

A number of significant issues emerged from the evaluation of the ALPS project, most of which were also features of the authors' earlier commissioned evaluation in 2004-5 of a much larger programme of support for scientific learning in schools supported by the National Endowment for Science, Technology and the Arts (NESTA). Please see Davies (2007) for a more complete report of the methodology and findings from that study. These were as follows:

1. External evaluation as an afterthought

Although our appointment as external evaluators had been announced at the showcase event and explained in a letter to participating schools, we experienced significant resistance from teachers and headteachers in our attempts to collect evaluative data from them. They clearly saw our presence as a threat and in some ways as 'checking up' on them rather than seeking to collect evidence of impact of the ALPS programme. This can be partly explained by the timing of the commission: had schools been aware that external evaluation was 'part of the

deal' from the outset we might have experienced far less suspicion. TDA (2007) reported that providers who placed the evaluation of impact at the heart of their provision were, unsurprisingly, in a stronger position to report on impact at the end of programmes. Piggot-Irvine (2006, p 486) identifies a number of features essential to effective evaluation of CPD programmes:

- Designing evaluation expectations prior to programme implementation
- Incorporating evaluation expectations within the professional development plan
- Using rigorous data-based information to determine the effectiveness of the programme
- Determining whether attitudes and practices of participants have changed for the better
- Determining whether the changes are manifest in classroom and school practices

Clearly, the first two of the above features were absent in the case of ALPS, where the evaluation was commissioned once it became apparent that there was some budget 'left over' owing to the withdrawal of three of the participating schools. The absence of a clear evaluation plan at the outset also compromised the achievement of Piggot-Irvine's other three criteria above, since rigorous pupil and teacher performance data at the beginning of the programme was absent, therefore determination of changes of attitude and practice was reliant on the self-reported memories of participants. Piggot-Irvine (2006) also questions whether an external evaluation, however thorough and knowledgeable, can really become sufficiently familiar with a CPD programme to explore issues in sufficient depth. Although there was some internal evaluation of the ALPS programme, it too was largely retrospective and over-reliant on the perceptions of participants after the event. Clearly, properly planned and integrated internal evaluations – perhaps incorporating an element of action research (Coombs, Lewis and Denning 2007) - are essential to demonstrating the impact of CPD programmes, yet in our experience of both this project and others (Davies 2007) is that this is rarely a feature of such initiatives.

2. Tensions between local authority, school and individual agendas

Bishop and Denley (2006) argue that a centrally-driven focus on raising pupil performance can distort CPD priorities, relegating essential subject knowledge and skill development for individual teachers below more generic content designed to meet institutional targets. They criticise the 'new professionalism' promoted by the UK government, which they argue undermines professional autonomy and leads to a technicist approach to curriculum delivery. Commenting on the establishment of a national network of Science Learning Centres, of which SLCSW is one, they warn that simply adding to the myriad of existing CPD science provision is unlikely to lead to success. Neither should these centres simply address the 'standards' agenda, focusing rather on a research-based focus on the development of individual teachers' "…enhanced knowledge and understanding of the pupils and a more positive disposition towards science" (p. 95). The involvement of SLCSW in ALPS clearly constitutes 'adding to existing provision', and the funding of the project by Bristol LA tended to focus it upon institutional performance targets, since Bristol is a low-performing authority in national league tables and is under significant political pressure to 'raise standards'. By agreeing to participate in the project, schools also 'bought into' this agenda, though the lack of specific numeric targets (which the Bristol LA advisor interviewed felt should have been set) somewhat softened the pressure.

The inclusion of 'intended outcomes' for participating teachers - in terms of their subject knowledge, confidence and subject leadership skills – can be seen as a concession to their individual agendas, relating closely to Fraser's (2007, pp. 156-157) definition of professional learning as: "the processes that, whether intuitive or deliberate, individual or social, result in specific changes in the professional knowledge, skills, attitudes, beliefs or actions of teachers." However, we need to note here that ALPS clearly lies towards the 'deliberate', formal end of Fraser's definition, which also includes much unplanned learning taking place within and beyond the school on a daily basis. However, even these seemingly individual outcomes were seen as instrumental within the school improvement agenda by participants' headteachers. According to OfSTED (2004): "The level of support given by headteachers, senior managers and other colleagues is a major factor in determining the extent to which participants are able to make use of what they have learned," whilst the involvement of the

whole school is seen by Johnson (2007) as essential to ensuring impact from CPD. Reynolds (1996) points to the importance of links between staff development strategies and modifications in curriculum or teaching necessary for impact upon pupils' learning. Thus, the participating teachers' agendas may, and arguably should have significant overlap with those of their schools in order to affect change (Guskey 1995), providing they are not completely submerged within the institutional drive for 'improvement'. Johnson (2007) asserts that it is the involvement of the whole school in any CPD programme which is the key to its success; change in the outlook or practice of just one or two individuals is unlikely to be sustained without support from colleagues and senior management. Although the support of headteachers for the ALPS project had been secured, there was little evidence at the time of evaluation of significant dissemination either within or beyond the project schools. Those schools which had sent two colleagues to training sessions appeared to have affected more change in pedagogy, but despite the best intentions of devoting in-school training days to ALPS, other national, LA or institutional priorities appeared to have distracted focus from the changes in practice advocated by the project.

3. Validity of short-term gains

The increasing focus on pupil performance as an indicator of CPD quality carries with it the danger of 'over-claiming' success based on short-term apparent gains, subject to Flecknoe's issues of causality and Hawthorn effect (2000, see above). Because of funding arrangements and political requirements for rapid feedback, too few programmes undertake the kind of longitudinal study carried out by Adey (2004) into the impact of the Cognitive Acceleration in Science Education (CASE) project, in which a quasi-experimental model claimed pupil attainment gains over a three-year period by comparison with those in control groups; indeed most of the effect appeared later rather than directly after the input. The requirement in our evaluation of the ALPS project to report within five months of commissioning – a similar time-scale to that we were allotted for the evaluation of NESTA's science learning programme (Davies 2007) – limited our analysis to national test data collected immediately after the project input. The opportunity to follow these pupils through into their secondary education was unavailable, and the only comparisons available were with the previous years' test data from the schools concerned – representing of course different cohorts of pupils. A further question here concerns the extent to which the national tests themselves constitute a valid and reliable measure of pupils' scientific ability. Tymms (2004) has criticised the UK government's claims for the success of education programmes based on test results, claiming that these are not consistent year on year and that apparent short-term gains have tended to level out. In the light of these criticisms it appears unlikely that anything can be read into the test results of pupil participants in the ALPS project, yet such is the political pressure on LAs and schools in the English system that such statistics are readily used as justification for expenditure on such programmes. This notion of 'value for money' was particularly prominent in the brief for our evaluation of NESTA's programme (Davies 2007) and also emerged as a significant factor for the schools in the ALPS evaluation. However, OfSTED (2004) report that value for money is a somewhat hazy concept in CPD and that few providers are able to cite evidence to justify it.

The pupil attitude data cited above also suffers from extreme short-termism, given that it was largely collected during the final event of the programme since the pupils concerned were shortly to transfer to secondary school. Although the use of 'pupil voice' to evidence the reactions of learners to changed practices is increasingly common in evaluations of CPD (Coombs et al 2007) it is highly susceptible to Hawthorn effect, particularly if elicited shortly after the programme. Such difficulties in attributing real shifts in attitude or gains in learning appear to have left many schools to regard the evaluation of inservice training as unimportant, since it is deemed too hard to judge effectiveness (ERO 2000). Rather than giving up in despair, this should lead us to an approach to evaluation which collects comparable data over a longer period, such as the study by McGregor (2004) of primary teachers' adoption of a more interactive pedagogy, in which pupils' learning in investigational situations was compared with the performance of pupils of the same year group carrying out the same investigations.

Conclusion

The ALPS project can be regarded as located primarily within the 'formal/planned' quadrant of teacher learning (McKinney et al., 2005). In terms of Kennedy's (2005) analytical framework it can be seen as relatively 'transmissive', in that new knowledge was supplied by 'experts' within the formal CPD sessions, although participants had an opportunity to practice these with support within their own classrooms. According to Fraser et al (2007, p. 165), "formal planned opportunities, which are essentially transmissive, are unlikely to result in transformative professional learning for teachers, because they attend primarily to occupational aspects…" rather than the personal attributes of the individual teacher. They argue that transmissive training, whilst it may impact upon pupil performance (in perhaps the superficial ways identified above) appears to be less successful in terms of teacher change and development. In order to become more 'transformative' (Kennedy 2005) the transmissive elements of ALPS need to be augmented by more informal, incidental learning opportunities such as chance encounters in the staffroom, team teaching or discussion of pupils work. There was some evidence from our evaluation that such activities were beginning to take place, but the time constraints made these very difficult to capture. What has become increasingly clear to us, both in the evaluation of ALPS and in our earlier work with NESTA is that, in the words of Piggot-Irvine (2006, p 483):

> "…effective professional development programmes cannot be quick-fix, or surface or skills translation (training) focused. These programmes need to be long term, embedded in practice and context, professionally informed, and sustained."

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Table 1: Change in Pupil Attitude during ALPS Project – negative versus positive ranks

		N
Attitude after - Attitude before	Negative Ranks	2(a)
	Positive Ranks	62(b)
	Ties	29(c)
	Total	93

a Attitude after < Attitude before
b Attitude after > Attitude before
c Attitude after = Attitude before

Table 2: Change in Pupil Attitude during ALPS Project: Wilcoxon Signed Ranks Test Statistics(b)

	Attitude after - Attitude before
Z	-6.872(a)
Asymp. Sig. (2-tailed)	.000

a Based on negative ranks.