Monitoring practical science in schools and colleges

Appendix 1: Research Methods

Durham University

Prepared for the Gatsby Charitable Foundation and the Wellcome Trust

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2 Ethics

The study was conducted under Durham University's guidelines for empirical research involving human subjects. These guidelines adhere to those of the British Educational Research Association (2011). The project was approved by Durham University School of Education Ethics Committee. Data are password-protected and held securely. No individuals or institutions participating in the study are identified. Participation in the study was voluntary and respondents were free to withdraw at any time. The staff completing the surveys and participating in the focus groups and telephone interviews were provided with information about the study in advance of the surveys and interviews being conducted.

3 Data collection instruments

Five instruments were used for data collection:

1. Survey of heads of science, science teachers and science technicians in schools and colleges (referred to as the "school staff survey")
2. Focus groups and telephone interviews with heads of science, science teachers and science technicians in schools and colleges (referred to as the "school focus groups and telephone interviews")
3. Survey of higher education staff involved with the teaching of first year undergraduate laboratory courses (referred to as "HE staff survey")
4. Telephone interviews with higher education staff involved with the teaching of first year undergraduate laboratory courses (referred to as "HE telephone interviews")
5. Survey of first year undergraduate students who take a laboratory class as part of their course (referred to as "HE student survey")

A sixth instrument was used in the first year of the study, however, due to low participation rates the findings are not presented in this report.

6. Survey of students in schools and colleges in years 10 and 12 in England, years 11 and 13 in Northern Ireland and Secondary 3 and 5 in Scotland (referred to as the "school student survey")

4 School staff survey

4.1 Preparation of the survey

The survey for heads of science, science teachers, and science technicians was developed for online administration. Full text for the school staff surveys is available in Appendix 4 for the three years of the study.

The survey content was agreed following consultation between the project team, advisory group members, consisting of representatives and advisors from the Gatsby Charitable Foundation, Wellcome Trust and Nuffield Foundation. The questions were designed to explore a range of factors influencing practical work provision. Source materials included data from previous surveys such as SCORE (2008, 2013) and the Trends in International Mathematics and Science Study (Martin, 2012).

4.2 Piloting the survey

Before the first use of the survey in year 1, a pilot version of the survey was administered to heads of science, teachers and technicians in 28 schools and colleges in England, Northern Ireland, Scotland and Wales. Twenty-four institutions from England responded, two from Scotland, and one each from Northern Ireland and Wales. Checks were made for functionality of the online format, readability and appropriateness of questions to context. Responses and feedback resulted in some modifications.

The pilot of the survey considered the comprehensibility of the questions and we therefore have no reason to believe that respondents did not understand the questions, so assume their responses reliably reflect their opinions, views and experiences at the time responses were recorded. Based on pilot data, through extensive re-working of many questions and careful use of responses, we ascribe validity to the findings on the basis that the survey is measuring according to intent.

The majority of the questions in the survey remained the same between in year 2 and 3 (note: in year 2 the questions for technicians were not included as the survey was only delivered to heads of science and science teachers). Readability and appropriateness of the context of any new or amended questions was checked through completion of a pre-release version of the questions, followed by discussion of the questions with teachers. Responses and feedback resulted in some modifications.

4.3 Obtaining the sample of schools and colleges

Up to date lists of schools and colleges were sourced from databases including Edubase[1], SPIRIT database[2] and Education Scotland[3].

School and college lists change continually due to name changes, amalgamations and closures. The project team used the sources available at the time of preparing the contact lists. All listed schools and colleges were contacted in year 1 of the study to establish a named contact person and functioning email address to receive the school staff survey invitation directly. In years 2 and 3 of the study, schools and colleges which were newly established since the previous year of the study were contacted to establish a named contact person and functioning email address to receive the school staff survey invitation directly.

Permission granted by the majority of Education Authorities in Scotland in year 1 of the study authorised ongoing contact with the same schools in these Education Authorities in years 2 and 3.

[1] https://get-information-schools.service.gov.uk/

[2] *SPIRIT is a professional and established suite of applications designed specifically for the education sector. The applications use The Education Company's central education database – the "education list" which is constantly updated and verified.* http://www.educationcompany.co.uk/our-apps

[3] http://www.gov.scot/Topics/Statistics/Browse/School-Education/Datasets/contactdetails

A small number of institutions expressly stated a wish not to be involved, for example, due to on-going re-organisation or staffing changes.

4.4 Encouraging participation

Responses were invited via emails to named contacts in all schools and colleges in England and through consent to contact schools via Education Authorities in Scotland. In year 1, schools and colleges in Northern Ireland and Wales were also emailed via a named contact.

Repeat reminder emails were sent every two to three weeks throughout the period to non-responding institutions as well as to institutions from which only a single response had been received. Differentiated emails were sent to institutions that had or had not participated in earlier years. The email subject line was also changed in all communications to reduce the risk of emails being flagged as junk mail. In year 1, follow-up telephone calls were made to institutions in groups where response rates were observed to be low.

Further responses were generated by publicising the survey using professional bodies, links with Initial Teacher Education partnerships, using social media (including Twitter and online forums), blog posts, flyers and information slides at events as well as a detailed presentation about the study at a science educator conference.

In years 2 and 3, five £100 Amazon gift vouchers were also offered as an incentive to complete the survey with participants being given the option to fill in their details to be entered into a prize draw on completion of the survey.

The intention in years 2 and 3 was to retain as many of the institutions responding in previous years as possible. In year 2, five paper copies of the survey were sent to 20% (N=97) of the institutions that had participated in year 1 but that had not responded to the year 2 survey by 22nd June 2016. Completed responses to the paper survey were entered into CVENT by staff at the Centre for Evaluation and Monitoring (CEM) at Durham University. The uptake of reponses via the paper format was not high, and so this method of encouraging participation was not used in year 3.

4.5 Administration of the survey

In years 1 and 2 the survey was delivered using online web survey software, “CVENT” (CVENT, 2015). In year 3, the survey was moved to be delivered using Bristol Online Survey “BOS” (Jisc, 2017). No respondents requested a paper copy of the survey.

The survey was available online for the following periods:

Year 1 - 20th May to 19th July 2015 (CVENT)

Year 2 - 3rd May 2016 to 31st July 2016 (CVENT)

Year 3 - 20th March 2017 to 31st July 2017 (BOS)

5 School focus groups and telephone interviews

5.1 Preparation of the focus group and interview protocol

The aim of the focus groups and telephone interviews was to gain insights into how and why changes to practical science are taking place and difficulties or issues faced by stakeholders.

The protocol for the focus groups and telephone interviews is provided in Appendix 5 and was agreed following consultation between the project team and advisory group.

5.2 Training of facilitators

Five facilitators were trained in June 2015 to conduct focus groups and one to also conduct telephone interviews. The training took place at Durham University and comprised: a presentation of focus groups as a research methodology; discussion of the draft focus group protocol; trialling and testing of equipment; and an opportunity to undertake a trial focus group. Post-training, the protocol was revised and the final version sent to all facilitators (the protocol is provided in Appendix 5). Facilitators were asked to encourage in-depth discussion to prompt rich data from interactions between group members. Refresher training was provided in April 2016 and April 2017 for the two facilitators continuing to conduct focus groups in year 2 and 3 and the single facilitator conducting the telephone interviews.

5.3 Selection of institutions to participate in focus groups and telephone interviews

In year 1, institutions invited to participate in the focus groups and telephone interviews were a subset of those responding to the school staff survey. Participating institutions were, as far as possible, chosen to reflect proportions of school or college types responding to the school staff survey in year 1. In years 2 and 3, the aim was to revisit institutions who had participated in focus groups and telephone interviews in year 1 and/or year 2. Additional institutions were invited to participate to replace institutions that were unable to participate in years 2 and/or 3. The additional schools were, as far as possible, chosen to: reflect proportions of school or college types responding to the staff survey; were school types of particular interest; or showed particularly interesting year 2 and/or 3 survey responses.

The following institutional factors were considered in selecting schools for the focus group and telephone interview sample:

- Single / mixed gender
- School type
- Age range

Focus groups were split across three regions of England to provide a geographic distribution of responses. Where possible, institutions of the same type were located in different geographic regions. The three regions were:

- South and South West – e.g. Kent, Sussex, Surrey, Hampshire, Cornwall, Devon, Dorset, Bristol, Somerset, Avon, Wiltshire, Gloucestershire
- London and East Anglia – e.g. Central and Greater London, Essex, Middlesex, Hertfordshire, Norfolk, Suffolk, Buckinghamshire, Bedfordshire
- North and Midlands – e.g. Cumbria, Yorkshire, Newcastle, Durham, Birmingham, Hull, East Midlands, West Midlands

Schools/colleges in Northern Ireland, Scotland and Wales were selected for telephone interviews based on location, for example:

- Urban – e.g. Glasgow, Aberdeen, Belfast, Cardiff, Swansea
- Rural – e.g. Highlands, Hebrides, mid-Wales, mid- and north- Northern Ireland
- Small town – e.g. Stirling, Inverness, Camarthen, Coleraine

5.4 Participation of staff in the focus groups and telephone interviews

School and college representatives were asked if the majority of science staff could attend the focus groups, including the head of science, teachers and technicians.

For the telephone interviews, up to five staff members were invited to participate either as individuals or in a group telephone call. In one case, a school was offered the opportunity to complete interview questions in writing to enable more than one member of staff member to participate. However, although documentation was sent to this school, no responses were received by this method.

Participants were provided with documentation in advance of focus groups and telephone interviews to ensure that the purpose of the activity was understood. Participants were informed that information given would be used for research purposes only and that they could withdraw at any time.

5.5 Administration of focus groups and telephone interviews

Focus groups lasted a maximum of one hour. In most cases, focus groups were carried out face-to-face by the facilitator, who travelled to the school or college. Three focus groups took place by video/teleconference in year 1 due to logistical constraints which prevented mutually agreeable times for a face-to-face visit. Facilitators used additional activities such as paired discussions between technicians and/or individual interviews with budget managers, that encouraged the examination of reasons for any changes in the quantity and quality of practical science.

Telephone interviews were semi-structured, following a protocol that mirrored the topics probed in focus groups (the protocol is provided in Appendix 5). Each telephone interview lasted a maximum of 30 minutes and was recorded. A single facilitator carried out all telephone interviews. Recordings were then transcribed as well as being listened to for analysis.

Focus groups and telephone interviews were conducted over the following periods:

Year 1 – June 2015 to November 2015

Year 2 – June 2016

Year 3 – May 2017 to July 2017

6 Higher Education staff survey

6.1 Preparation of the survey

The survey for Higher Education (HE) staff involved with the teaching of first year undergraduate students was developed for online administration. (see Appendix 6 for the full survey for each of the three years) The survey content was agreed following consultation between the project team and the study advisory group members. The questions were designed to explore a range of factors around undergraduate students' skills and preparedness on arrival at university. Source materials included data from previous surveys such as (Grant, 2011), SCORE (SCORE, 2008; 2013) and the Trends in International Mathematics and Science Study (Martin et al., 2012).

Readability and appropriateness of questions to context were checked through completion of a pre-release version of the survey in year 1 followed by discussion of the content with members of experienced academic staff teaching undergraduate laboratory courses in different subjects and universities. Responses and feedback resulted in some modifications. Minimal changes were made to the survey in years 2 and 3. Checks were made for functionality of the online format.

6.2 Obtaining the sample of HE staff

The letter from the Secretary of State to Ofqual in March 2013 stated that an intention of the proposed reforms to A levels should be to involve universities (particularly the best, research intensive universities) in the development of the new A level qualifications. Therefore, the survey of Higher Education staff targeted a list of the top 28 universities identified using overall Times Good University Guide rankings in each of the three years and individual departmental rankings in biology, chemistry and physics. Telephone calls were made to each department in the listed universities to identify email addresses for first year laboratory coordinators and departmental administrators who were then asked to distribute the survey to anyone involved in the teaching of first year undergraduate laboratories.

6.3 Encouraging participation

Responses were invited via emails to named contacts in biological sciences, chemistry and physics departments in the top 28 (26 in year 3) universities across the UK. In years 2 and 3, departments that had participated in previous years but which were not in the current year's list of universities, were also contacted with a request to participate again in year 2 and 3. The intention was to retain as many institutions as possible through all three years of the study. General requests for participation via professional bodies were also used. Repeat reminders were sent throughout the period the survey was live. Response rates were also monitored throughout the period and follow-up telephone calls were made to departments where no members of staff had responded to the survey.

6.4 Administration of the survey

In years 1 and 2 the survey was delivered using online web survey software, "CVENT" (CVENT, 2015). In year 3, the survey was moved to be delivered using Bristol Online Survey "BOS" (Jisc, 2017). No respondents requested a paper copy of the survey.

The survey was available online for the following periods:

Year 1 - 16th November 2015 until 7th February 2016 (CVENT)

Year 2 - 26th October 2016 until 31st January 2017 (CVENT)

Year 3 - 6th November 2017 until 20th December 2017 (BOS)

7 Higher Education telephone interviews

7.1 Preparation of the interview protocol

The aim of the telephone interviews was to gain more insights into how well science practical work teaching in post-16 education prepares students for studying science in Higher Education, and any difficulties or issues faced by stakeholders.

The protocol for the interviews was agreed following consultation between the project team, and advisory group. The facilitator was asked to encourage in-depth discussion.

7.2 Training of facilitators

A single facilitator carried out all telephone interviews. Training for the facilitator was conducted at Durham University in June 2015. Refresher training was provided in April 2016 and April 2017.

7.3 Selection of staff to participate in telephone interviews

HE staff who had expressed an interest via a question at the end of the HE staff survey were contacted to participate in telephone interviews.

Participating staff were, as far as possible, chosen to provide an even spread across biological sciences, chemistry and physics departments. In years 2 and 3, the aim was to revisit the staff who had participated in telephone interviews in year 1 and/or year 2. Additional staff were invited to participate to replace participants that were unable to be interviewed in years 2 and/or 3.

7.4 Administration of telephone interviews

Telephone interviews were semi-structured, following the protocol which is provided in Appendix 8 for each of the three years of the study. Each telephone interview lasted a maximum of 30 minutes and was recorded. Recordings were then transcribed.

Telephone interviews were conducted over the following periods:

Year 1 – November 2015 to February 2016

Year 2 – November 2016 to January 2017

Year 3 – November 2017 to December 2017

8 Higher Education student survey

8.1 Preparation of the survey

The survey for first year undergraduate students (see Appendix 7 for the full survey for each of the three years) was developed for both paper-based and online administration. The survey content was agreed following consultation between the project team and advisory group members. Source materials for the original development included data from previous surveys such as SCORE (SCORE, 2008; 2013) and the Trends in International Mathematics and Science Study (Martin et al., 2012). The survey remained largely unchanged in years 2 and 3 from the version used in year 1 of the study.

The readability and appropriateness of questions to context were tested in year 1 with students through their completion of a pre-release version of the survey and subsequent discussion with them about the content. Modifications were made in response to the feedback before administration to the main sample. Checks were made for functionality of the online format.

8.2 Obtaining the sample of HE students and encouraging participation

Surveys were distributed by members of staff who had expressed an interest in distributing surveys to their students in a question at the end of the HE staff survey. Subsequent emails and telephone calls were used to contact these staff to encourage the distribution of the surveys. HE staff participating in the HE telephone calls were also encouraged to distribute the survey. Feedback from staff at the end of the year 1 survey period was that in many cases it was not possible for them to distribute surveys to students as their university had a policy which prevented them from asking students to complete surveys from outside of their own institution, to reduce the burden on students' time. Therefore, in years 2 and 3, participants were also recruited via emails to the students unions at target institutions asking them to forward the survey email to science course representatives. Recruitment via emails from professional bodies was also carried out along with promotion of the survey on social media.

8.3 Administration of the survey

In year 1, the survey was provided either as paper copies or via a link in an invitation email, in years 2 and 3, only online versions were provided. The online version of the survey was delivered using online web survey software, "CVENT" (CVENT, 2015) in years 1 and 2. In year 3, the survey was moved to be delivered using Bristol Online Survey "BOS" (Jisc, 2017). No respondents requested a paper copy of the survey.

Year 1 - 16th November 2015 until 7th February 2016 (CVENT)

Year 2 - 26th October 2016 until 31st January 2017 (CVENT)

Year 3 - 7th November 2017 until 7th January 2017 (BOS)

9 Data preparation

9.1 Survey data (school and HE)

Survey data were transferred from CVENT or BOS into the SPSS statistical package for analysis (IBM, 2012). Data were cleaned to remove missing and anomalous data and entries which were clearly incorrect were excluded. Hence, response totals do not always add up to the total number of respondents. Following data cleaning, the SPSS data-file was interrogated to generate the reported data.

9.1.1 Validity and reliability

The pre-release assessment of the surveys considered the comprehensibility of the questions and we therefore have no reason to believe that respondents did not understand the questions, so assume their responses reliably reflect their opinions, views and experiences at the time responses were recorded. Based on pre-release survey responses, minor reworking of some questions and careful analysis of responses, we ascribe validity to the findings on the basis that the survey is measuring according to intent.

9.2 Focus group and telephone interviews (school and HE) data

The recordings from the focus groups and telephone interviews were transcribed as well as listened to and the data analysed using NVivo software to code the data to assist with a thematic analysis (NVivo, 2012).

9.2.1 Validity and reliability

9.2.1.1 Methodological choices

Techniques were applied to reduce or eliminate bias in the analysis of the data. For example, telephone interviews were conducted by the same researcher, eliminating the possibility of researcher variability bias. Focus groups and telephone interviews were transcribed, eliminating any researcher bias occurring during note-taking. Focus group leader training, also attended by the telephone interviewer, and focus group and interview schedules reduced bias due to focus group leader variability. Audio recordings of proceedings were listened to identify possible in-group bias. This is discussed in the next section.

9.2.1.2 Analysing recordings for bias

One focus group led by each leader and three telephone interview recordings were selected for the investigation of bias in year 1. All recordings showed that training and question schedules were adhered to correctly. Hence, bias due to differences between focus group leaders and the interviewer was minimised.

Transcriptions were checked for accuracy. Errors such as “voiding body” rather than “awarding body” were corrected prior to analysis. Occasional omissions of technical words were identified using time markers enabling cross-reference to audio files for confirmation, for example, “f=ma” and “Planck’s Constant”.

Follow-up questions were judged appropriate as these flowed naturally from the discussion occurring. A few leading questions, such as “Is it important that you get really high exam results because you are a high priority subject?” were found. These mainly provided detail about links between core subjects and exam pressure.

The responses to the questions were analysed to ensure that they were valid, i.e. that they were “doing what they were supposed to be doing”. From this, respondents appeared to understand the

meaning of the questions in the way that they were intended. In the few cases where there was slight ambiguity around the intention of the question, the focus group leader probed further with follow-up questions.

Transcripts were also examined for bias by participant type, for example, senior or specific colleagues dominating discussion. In most cases, all participants seemed to express opinions equally. When one focus group member seemed relatively quiet, the group leader asked him/her direct questions to elicit opinion. Some responses obtained this way disagreed with senior colleagues' views, demonstrating lack of intimidation. Regular checks took place within the focus group discussions to ascertain if views were held by all those present.

Systematic bias due to institutions operating in a "high stakes" assessment and inspection system may occur. In year 1 of the study participants in English institutions appeared to collectively focus on positive aspects of their work, and seemed less likely to admit weaknesses. This may have arisen due to pressure to perform well in inspections.

9.2.1.3 Triangulation

Survey and focus group/telephone interview data were compared for agreement and discrepancies. Bias in qualitative data would lead to discrepancies between the two data sets. A limited number of discrepancies were found. This increases confidence in data validity and reliability.

9.2.1.4 Saturation

Saturation was achieved in analysing focus group and telephone interview data. That is, no new themes appeared in later transcripts that were analysed. This, coupled with the lack of discrepancies observed between focus group/telephone interview and survey data, suggests the focus group and telephone interview sample size represented views of the whole population of survey respondents.

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