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Ethical considerations of chemistry education research involving 'human subjects'

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One obvious way that chemistry education research (CER) is different from research in most areas of chemistry is that where chemistry is largely concerned with inanimate substances, education concerns people. That does not make chemistry education completely unique in the chemical sciences (e.g. some other areas of chemistry may investigate the effect of new compounds on human patients), but in general we think of chemical research as involving the manipulation of inanimate material, where the people involved in the research tend to be those observing the outcomes of the intervention, and not being subject to it.

Chemistry education research is however rather different in this regard. Certainly, not all chemistry education research need involve 'human subjects' (i.e., people) - so for example studies may review existing research literature, or analyse texts or curriculum documents. However, educational research is at its core about teaching and learning. Learning is something that happens in the minds of people, and teaching is activity directed - by people - towards learners. Sometimes the teacher and learner may be the same person when learning is self-directed, but more commonly we can distinguish teachers and students. Most CER studies are carried out with human participants who provide data through allowing themselves to be observed, or by representing

aspects of their thinking for researchers in the context of interviews, questionnaires, and various other data collection instruments.

There are clearly implications of working with people that makes this kind of research more complicated than bench work with chemical samples. Samples of a substance will 'behave' according to their inherent natures, and the conditions they are exposed to, without any danger of the outcomes being moderated by personal or social concerns. Science can treat samples as the objects of investigation, and generalise from results because a well-characterised sample of some substance can be considered to stand for all other samples of the same type (i.e., taking into account purity, concentration, grain size, etc). Moreover, the samples do not take the enquiries of researchers personally: they do not take offence at being strongly heated, or potentially respond differently because the researcher has a beard, or a soft voice, or has film-star looks. The samples do not think about - and so perhaps become influenced by - what the researcher is trying to find out. The samples will not try to impress the researcher, or other study participants, and nor do they perform differently when it is getting late in the day or after they have had an argument with family members. Researchers in CER have then to consider issues of context and representativeness that are much more nuanced than their colleagues working with chemical samples.

The RSC's ethical guidance to authors

People are not only more complex than samples of substances, but they also have inherent rights that chemicals do not have. People are entitled to expect to be well treated, and respected, and to determine their involvement (or not) in research. So the ethical considerations of research involving people go far beyond what is expected in research on material samples in the chemistry laboratory (such matters as adequately acknowledging sources, avoiding multiple publication, etc.). The Royal Society of Chemistry (RSC) publishes on its website guidance to authors on the ethical aspects of research that will be reported in submissions to its journals. Some aspects of this relate to general issues such as who can be listed as an author of a published paper and the need to report work accurately and completely. However, there is also a more specific section on research 'involving live subjects'. This includes the guidance that:

“In cases where a study involves the use of live animals or human subjects, the author should include in the Methods/Experimental section of the manuscript a statement that all experiments were performed in compliance with the relevant laws and institutional guidelines, and also state the institutional committee(s) that have approved the experiments. They should also include a statement that informed consent was obtained for any experimentation with human subjects.”

As an editor I find that many submissions to ***Chemistry Education Research and Practice*** (CERP) do not follow this protocol, and often authors have to be requested to add information regarding the ethical safeguards they have observed. This is especially important for an international journal when expectations may vary considerably between educational systems. As a responsible journal, CERP should only publish work that meets both (i) the ethical guidelines in place in the local context where research is undertaken and (ii) the broad expectations of the international chemistry education research community. Given that many authors do not think to comment on these issues in their submissions, it may be helpful to set out some of the key issues that need to be taken into account when considering the ethical aspects of research in chemistry education.

Do no harm

A key imperative is that researchers should not negatively impact upon the people who participate in their research. In chemistry education studies we are unlikely to risk inflicting physical harm to our participants. If our research involved laboratory activities these would be subject to the usual health and safety considerations and risk assessments, and this should avoid research participants being put at risk from avoidable accidents.

Yet not all risks are physical in nature. Research in chemistry education commonly involves observing teaching and learning contexts, asking people to complete instruments such as questionnaires or interviewing them - perhaps including tasks such as think aloud, or sorting activities. Physical harm is very unlikely in these situations, yet some people can get very stressed or tired by the intensity of some data collection activities. We also risk confusing people, or making them doubt the adequacy of their level of knowledge and understanding - or even their ability in the subject - for example if activities are very challenging. There is certainly potential to damage a person's motivation, self-efficacy, or confidence if we set them tasks that they find too difficult or which lead them to evaluate their own performance as unsatisfactory. This is no reason to not undertake potentially useful research, but it is something that needs to be considered in planning studies, and requires reasonable efforts to include sensible safeguards (such as appropriate

briefings/debriefing which may, where appropriate, suggest that tasks may not have ready or clear answers, and so forth.) Such issues should be considered as part of research design, and where necessary developed through appropriate pilot work, and so should be mentioned in published reports when describing methodology.

Another kind of harm is of an educational nature. Journals sometimes receive submissions where authors have attempted to evaluate the efficacy of some educational treatment by using an experimental design with a control (or comparison) group. The logic here is that we expect learners to learn from instruction, but we may be able to show that an innovative approach leads to substantially *more*, or *deeper* or *qualitatively different*, learning than the 'standard fare' by comparing intervention and comparison groups. Such designs are subject to a range of threats to validity (expectancy effects, novelty effects, issues with matching the groups, and the teachers, etc) that can undermine their value - but then all research designs have some weaknesses and involve compromises. Any research that uses valuable resources (including participant time) for a study with a design so weak that it is clearly unlikely to provide useful data is inherently unethical (British Educational Research Association, 2011). Care is needed to ensure that a design is not so compromised by recognised threats to validity as to make the study pointless because no robust inferences are possible.

However, of more concern, is the way comparison groups may sometimes be established. Occasionally the way studies are described suggests that comparison groups are deliberately set up to be taught in ways that would generally be recognised as inadequate to allow the study to show that the innovation is superior. So, for example, authors may report that the teaching in the comparison condition was deliberately based upon teacher-led instruction and textbook presentations that did not link to students' own ideas and interests, and did not include discussion activities. In such circumstances, it is hardly novel to report that a more pedagogically sound approach using an engaging technique informed by widely accepted educational theory was found to be superior.

Such research is worrying at two levels. For one thing, it may seem that teaching in one group was deliberately restricted so the students in that 'condition' were offered intentionally substandard instruction. This seems especially likely when in order to 'control for the teacher variable' the same teacher has taught two parallel classes through contrasting approaches (as clearly the teacher of the comparison group both knows how to, and is able to, teach in a more pedagogically sound way). Where different teachers are involved, researchers may sometimes argue that they did

nothing to direct the teaching in the comparison condition, which represents what is 'traditional' in that context. Even then, the reader may wonder if at the very least this suggests the comparison is of (a) a class taught by a teacher who is more motivated, more highly skilled, and/or better prepared in working with the innovation, with (b) a class taught by a teacher either unwilling or unable to adapt their teaching. This may not provide the most informative basis for comparison.

Even if there is an argument that the study is a fair comparison in regards to the teacher and this does not act as a confound to the intended comparison, such studies can seem to be set out to find whether a teaching approach *which is already known to generally be effective* is better than an approach *that is widely acknowledged to be limited* - so there seems little value in such studies, unless there are genuine theoretical reasons to be unsure whether the implemented innovation will be effective in some particular educational context. Just as it would be inappropriate to ask someone to teach a class in an unfamiliar way without good grounds for suspecting the innovation may be beneficial, it is equally inappropriate to set up experimental tests of well-established ways of teaching already widely shown to be effective unless there are theoretical reasons to suspect the study offers genuine insight into the range of application of the innovation because of some specific feature of the study context (Taber, 2012b).

Informed consent

Another issue that arises regularly with submissions to the journal is whether study participants have offered informed consent, as expected in the RSC ethical guidelines for authors quoted above. That is, it may not be clear if those involved are aware they are participating in a research project, or what the data might be used for (in published reports for example), and whether they have agreed to be involved aware that they could decline or leave the study at any point without prejudice. In a University setting this may be relatively straightforward as students are adults who are able to make decisions about joining a study as long as they are sufficiently informed about what it is they are volunteering for. The situation is complicated in schools where parental permission may also be appropriate in some cases, or where for some purposes teachers may act *in loco parentis* and decide that as long as the children volunteer there is no need for parental permission to be sought. The situation is likely to be different when a researcher is simply observing a class of children who will be anonymous rather than if children are videoed, or if individual children are interviewed in depth about their ideas or views.

Informed consent does not mean that participants necessarily have to have a detailed account of the research purposes (which may mean little for younger participants, and could potentially bias the study if it leads to participants consciously focusing on what the researchers are interested in), but they do have to be told enough so that they are able to judge that the study is something worthwhile that they wish to support, and potential participants need to know at the outset what level of involvement is involved - what they will be asked to do, when, and under what circumstances. Research data is a gift from study participants to researchers (Limerick, Burgess-Limerick, & Grace, 1996) and is not something that can be assumed and taken for granted.

It is reasonable for a researcher in explaining why the research is valuable to suggest how the potential participant will potentially be helping future teachers and/or students by participating - but no pressure should be applied, and it should be clear there will no sanctions for non-participation. It is a basic democratic principle that individuals have a right to make a free choice over whether to contribute to a study or not (British Educational Research Association, 2011). Any coercion makes the research unethical - as does collecting research data surreptitiously - for example if students believed they were completing a test for their teacher as part of normal classroom practice, but the teacher was actually administering a research instrument on behalf of researchers without the knowledge and consent of the learners.

This last point may seem to be pedantic. After all, if a teacher sets an activity on behalf of a researcher believing both that the activity will contribute to educational enquiry, and that the activity may actually be a useful learning experience for the students, then there might seem to be no problem. The teacher here acts as a gatekeeper, looking after the interests of the learners, and there is something of a grey area if a teacher feels that the research activity is a useful classroom learning opportunity, and so wishes to include it in a teaching scheme because of its inherent value as a classroom activity *as well as* on behalf of the researcher. Some institutions deal with this by putting agreements in place with students or (in the case of schools) their parents at admission that in effect provides blanket permission for learners to participate in certain kinds of unobtrusive research activities within the usual classroom context when learners' inputs will be limited and remain anonymous. Activities that go beyond this (for example outside of the normal timetable) still require specific explicit consent

Complications of research undertaken in ones own institution

Particular complications may occur when a researcher is an insider to the research context. Much research in education is theory-directed (looking to add to 'public knowledge'), and involves the development of research questions based upon the review of existing literature, that in turn lead to the researchers seeking a suitable context (or contexts) to carry out their study. This is where gatekeepers will protect the interests of potential participants. The researchers have to persuade the authorities responsible for the research context (principals, deans, department chairs, local education office officials, or sometimes even the national ministry in some contexts) that what they are doing is worthwhile, and not overly disruptive of normal educational activity, before they get access to invite participants into the study.

This may be contrasted with context-directed research where lecturers or teachers see a potential to improve some aspect of practice in their own classrooms or institutions, and carry out enquiry primarily for the purpose of informing and improving educational provision in their own professional context (Taber, 2013a). A teacher who decides to make a lecture course more interactive and then to evaluate how this impacts learning and students' perceptions as part of the usual processes of reflective practice and professional improvement is certainly undertaking research - yet not as a discrete activity but rather as part of good professional practice. The lecturer would hardly expect to have to get informed consent from her students to innovate in this way: rather the students should trust the teacher's professionalism and be pleased they have a teacher who is concerned with the quality of learning and the learner experience. Of course such innovations can sometimes go wrong (or may simply take more than one pass through to become effective), but that is no reason to discourage teachers from trying things out as long as they have first reviewed the relevant literature to inform them in selecting and implementing innovations likely to be effective in their particular contexts. In this situation the 'data' is collected solely for improving practice in the specific context and might be better seen as part of ongoing evaluation and professional development than as formal research (Wilkins, 2011).

Complications arise however when practitioners wish to prepare public reports of enquiry with their own students or colleagues. We would expect practitioners to share their accounts of good practice with their network of colleagues - but it is not so clear whether this should include publishing formal reports of their work drawing upon data collected during what was set up as context-directed enquiry. Students and colleagues may feel misled to find that an activity presented

as an internal evaluation of an attempt to improve practice becomes the focus of a formal report of research in which they have become unwitting participants.

Where the original activity was genuinely intended as context-directed innovation, perhaps undertaken with a spirit of action research (Tripp, 2005), it is unlikely that the enquiry would support a formal research paper that meets the quality criteria of a research journal. Yet this is certainly not impossible if the study was carefully conceptualised and planned, and drew upon rigorous data collection and analysis - and either produced novel outcomes, or had potential to demonstrate novelty through the particular nature of the study context. In this situation the practitioner-researcher may feel it would be worthwhile reporting the work beyond the original context. It may be possible to collect suitable permissions from the participants after the fact - but the best advice is to always seek informed consent in advance if there is any reasonable possibility that the researcher will wish to publish on the work later.

Some studies submitted for publication offer a different kind of hybrid of theory-directed and context-directed research. Sometimes in studies motivated by theoretical considerations researchers decide to collect data in their own institution to answer their research questions. This need not necessarily be problematic, but clearly invites potential complications as the usual gatekeepers may be bypassed. Some studies I have seen submitted to journals read as though researchers have simply decided to set classroom activities to their own students as a source of data for research studies without consideration of either obtaining informed consent, nor of the potential educational value of the activity for the learners. Perhaps the written accounts give a false impression in these cases, but a reader of research expects it to be clear that teachers are not simply using their own students as sources of data for research publications without regard to the students' interests or preferences.

It is also well recognised that simply telling students (or less senior colleagues) that they are free to decline participation may not be enough when the request comes from a teacher or senior colleague in a position of relative authority and power. There has to be a genuine sense that participants are free to choose without fear of sanctions, consequences or differential treatment. For this reason many institutions require such studies to pass through formal processes of institutional review (Kimmel, 2007) - if often only a cursory level to confirm an activity is exempted from needing a full review at board level. Where such a procedure is not in place, it is often possible for the researcher(s) to enrol the help of a senior colleague in a position to intervene or even veto the activity who can act as a point of contact for potential or actual

participants with any concerns (Taber, 2013a). In either case, the author of a research study should inform readers of the safeguards in place, so it is clear that the interests of participants - and anyone declining to participate in a study - have been given due concern.

If in doubt, play safe

Most people working in chemistry education have high ethical standards, and a strong concern for the rights and well being of their colleagues and students. Few would deliberately look to take advantage of others for the sake of their own research, and most would not seek to do anything that was against the interests of their students (or which might bring their own integrity into question). However, often those of us engrossed in research issues and questions may find it difficult to see why others do not share our enthusiasm and automatically consider our research worthy of their time and input. There are also particular issues when we are researching in our own professional contexts as the lines between research and other professional activities may not always be clear cut - and indeed the status of innovation and evaluation can creep over time from being focused on local improvement to being part of a wider research agenda. Research should inform teaching, and there is certainly nothing intrinsically wrong with research with our own colleagues and students, as long as we employ sensible safeguards and make sure these are clear to all involved.

Ultimately ethical guidelines are just that, guidelines, and individual researchers have to apply them sensitively and sensibly to the complexities of their particular studies. The ethical guidelines of journals are intended to ensure that all published studies can be seen to have clearly followed basic ethical protocols. Authors are reminded to include information about ethical procedures adopted in the methodology sections of their reports so that it is clear that research designs have been subject to any relevant institutional reviews, and that all those participating in studies are doing so in full knowledge of their involvement, and having made deliberate decisions to contribute. This helps to give all of us peace of mind that our enthusiasm for CER cannot get ahead of our responsibilities to those who give us access to teaching and learning contexts and offer us the gift of data - without which we have no research.

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