Wishart, J., Green, DJ., Joubert, MV., & Triggs, PA. (2011). Discussing ethical issues in school science: An investigation into the opportunities to practise and develop arguments offered by online and face-to-face discussions. *International Journal of Science Education, Part B: Communication and Public Engagement*, *1*(1), 47 - 69. https://doi.org/10.1080/21548455.2010.543863

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Journal:	*International Journal of Science Education*
Manuscript ID:	TSED-2010-0364-B
Manuscript Type:	Research Paper
Keywords :	argumentation, ethics, science education
Keywords (user):	online, discussion

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Abstract

Recent changes in UK science curricula mean that it is now expected that pupils are taught about socio-scientific applications and implications of science however, finding time to incorporate associated discussions and to set up forums for debate is challenging for teachers. This paper reports on a project to investigate different approaches to engaging students in argument and discussion including online debate outside lesson time. The project involved incorporating different types of discussion into sixth form (students aged 16-17) biology lessons. An opportunity sample of six experienced teachers and their classes (totalling 84 students) was recruited. In all, five online discussions between schools, one online within school discussion and four face to face discussions were analysed for their quality of argument using the framework proposed by Erduran, Simon and Osborne (2004). Results indicate that, within this sample, the dialogue in online discussions demonstrated higher levels of argumentation than that in face to face discussions. Students in the face to face discussions volunteered less evidence to support their arguments and were less likely to challenge each other's points. Students reported they learned slightly more from online discussion than face to face discussion, this was confirmed by their teachers. Whilst this study is clearly limited by size and the unanticipated events within school that limited the amount of data collected it was concluded that online discussion is worth further investigation by education practitioners. It offers opportunities to bring students together across time and space to practise justifying and defending their point of view.

Deleted: a

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Introduction

The first decade of the 21st century finds science education in schools set in a shifting context where curricula and the range of learning opportunities offered by the use of information and communications technology (ICT) in UK schools are both constantly developing. The extent to which teachers have responded to new requirements to develop students' capacity to engage critically with social and ethical issues in science is varied. Equally varied is the development of their confidence in an extended repertoire of teaching approaches to support such learning. Finding time to incorporate discussion and debate, and to locate resources and technologies that might be helpful is challenging for teachers. This paper reports on a project which investigated the use of different approaches to engaging students in argumentation and discussion; it focuses on a role for online resources.

When Millar and Osborne (1998) highlighted the need for the public, in a healthy and vibrant democracy, to have a broad understanding of major scientific ideas and to be able to engage critically with issues and arguments which involve scientific knowledge, they set in motion an overhaul of science curricula across the UK that promoted understanding of science–related social and ethical issues. This move is international with Zeidler and Keefer (2003) pointing out that professional associations in science across the globe recognise the importance of broadly conceptualising scientific literacy to include informed decision making, dealing sensibly with moral reasoning and ethical issues, and understanding the connections inherent in socio-scientific issues. Thus, teaching science in the 21st century requires ensuring that students consider associated ethical issues in depth, addressing both the science content and the underlying moral and socio-scientific argument.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

This shift in approach has been well received by most teachers though Hall (2004) in particular is critical, believing that a clear demarcation between questions that science can answer and those it can't, is helpful to pupils. Some remain sceptical, for example Donnelly (2004) questions the view that socio-scientific issues fall clearly within the remit of a science curriculum while others believe science education should be value-free (Sadler et al, 2006). However, even keen bioscience teachers can be distinctly uncomfortable about teaching issues in sensitive subjects such as genetic screening and abortion and many are unpractised in using teaching approaches that encourage argument and in managing discussion. Furthermore, students seem to find it difficult to develop written arguments. One examination board (Salters-Nuffield Advanced Biology, 2003) pointed out that students were losing marks through their inability to express their arguments adequately in writing. In response to such concerns the Wellcome Trust announced funding for projects to boost teachers' confidence in handling socio-scientific issues (Wellcome, 2003) and the Bioethics Education Project (BEEP) (www.beep.ac.uk) was set up. This project comprised the development and evaluation of an interactive teaching resource for secondary school science teachers and their students that highlighted the moral, ethical, social, economic and environmental implications and applications of biology. It provides up to date, balanced information to support students in developing their arguments when debating ethical issues in science and to facilitate opportunities for student debate through online discussion.

Levinson (2003) pointed out that opportunities for discussion are central to the successful teaching of the ethical considerations associated with modern biological science and its methods. Newton, Driver and Osborne (1999) consider such active participation by learners in the

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

discourse of science lessons to be central to the provision of an enabling learning environment. They consider that discussion enables students to articulate their reasons for supporting a particular standpoint and to attempt to justify their views. Other students will challenge them, express doubts and present alternatives, and a clearer understanding for the whole group will emerge. The general assumption is that discussion will be face to face. However, teachers report that opportunities for face to face discussion in UK science lessons are few and far between. In 1999, Newton, Driver and Osborne attributed this lack of opportunities to external pressures imposed upon science teachers in England by the National Curriculum and its assessment system. In their review of the state of Science Education in Europe; Osborne and Dillon (2008) report similar issues occurring across Europe. They found it rare, for instance, to see any work that involves the construction of an argument and report that contemporary school science education in Europe offers little opportunity for a pedagogical approach centred on deep understanding that requires space for students to discuss, to think critically and to consider others' views. In the UK the introduction of modular external examinations in 2000 has added to teachers' perceived pressures on available classroom time. Such pressures mean that it may be difficult to change teachers' pedagogical repertoires, as also identified earlier by Newton, Driver and Osborne (1999). This suggests that, without opportunities to practise, many teachers are likely to continue to lack confidence in managing face to face discussions.

One approach to providing teachers with these sorts of opportunities is to use online discussion boards. An online discussion board provides school students with a realistic forum where they can practise and develop their arguments outside of class time before having to produce them in the A level examination. Bonk and Graham (2006) point out that in online discussion learners

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

have more time in which to consider carefully and provide evidence for their claims. Additionally Sugrue (2000) believes learning through discussion afforded by an online environment should be particularly effective as it enables students to refine and construct shared understandings of knowledge.

But is there any empirical evidence that online discussion supports the active participation that Newton, Driver and Osborne (*ibid*) associated with engagement and science learning? Online discussion has been used effectively in Higher Education (HE) (Salmon, 2000) for supporting student learning where Littleton (1999) suggests that it can directly enhance learning through collaboration between students and between students and their tutors. It has also been well received in US college undergraduate ethics programmes (Fleetwood et al, 2000). However, there has been little or no use of online discussion in science learning and teaching in UK schools. If the approaches used in HE can be successfully transferred to schools, they could offer opportunities for students to practise their arguments in discussion outside lesson time and even for students from a range of schools to join together to form the critical mass needed to seed worthwhile discussions. It was for this reason that online discussion boards were included in the BEEP resources.

The DAIS (Discussion and Argument in Science) Project described in this paper and incorporating BEEP, was set up to compare the opportunities for engagement in argument offered by classroom based face to face discussion and online discussions. Previous research directly comparing online discussions between students with face to face discussions does not specifically involve discussions of ethical issues in science. In addition it mostly involves older,

Deleted: different media

graduate students and is inconclusive. For instance Wang and Woo (2007) found that online discussions were more comfortable for participants and offered more equal opportunities for group members to voice their opinions but that communication in face-to-face discussions was easier as participants could talk to each other in real-time, see their facial expressions and clarify matters immediately. Meyer (2003) compared the experiences of two classes of American graduate students in face-to-face discussions with online threaded discussions, which revealed that when the students were involved in online discussions they exhibited more higher-order thinking through contributing more exploratory and integrative comments to the discussion. Meyer (*ibid*) concluded that whilst there are advantages to holding discussions in either setting, students most frequently noted that using online discussions increased the amount of time they spent on class objectives and that they appreciated the extra time for reflection on coursework issues. However Tiene (2000) reports that the face-to-face format had value for his students in particular for its immediacy and energy. Again at an American University, he surveyed five graduate level classes recording their perceptions of the face to face discussions held in class and the online listserv based discussions held between classes. He found that most students preferred face-to-face discussions to online discussions even though they believed that online discussions could offer more convenience and flexibility. Positive features of online discussions included the asynchronous aspect and the use of the written word; potential drawbacks, like technical barriers and a lack of visual cues, were not perceived as significant disadvantages.

Assessing 'quality' in an online discussion is generally considered to be challenging. Joiner and Jones (2003) trialled a scheme developed by Felton & Kuhn (2001) to evaluate the development of argumentative reasoning amongst undergraduates asked to debate the contentious issue of

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

smacking young children in either online discussion or face-to-face discussion. They found that the quality of argumentation used in face-to-face was higher than that used in the online discussions but they later questioned their measure which focused on transactions and attempts to engage discussion partners in discourse. Other researchers have focused on: conversation analysis (Gibson, 2009) which showed online discussion displays similar characteristics to face to face e.g. sequential organisation of talk and turn taking; perspective taking (Jarvela and Hakkinen, 2000) where identifying participants' perspectives proved problematic; and content analysis (Hara, Bonk and Angeli, 2002) where the cognitive and metacognitive components were found to be particularly difficult to evaluate and interpret. Mellar and Howell-Richardson (1999) review a number of techniques for analysing online interaction but do not address this issue of quality. However, drawing on science education research literature rather than that on evaluating online discussion, we note Erduran, Simon and Osborne (2004) introduced a way of measuring the quality of argumentation that is based on work by Toulmin (1958). Originally intended for enhancing the quality of argument in school science lessons in England, Erduran et al's (2004) framework of levels of argument has recently been tested in a number of countries including the United States (Sadler and Fowler, 2006), Australia (Dawson and Venville, 2008), Turkey (Erduran, Ardac and Yakmaci-Guzel, 2006) and Brazil (Sá and Queiroz, 2007). The framework itself is developed from Toulmin's (*ibid*) Argument Pattern (TAP) which illustrates the structure of an argument in terms of an interconnected set of utterances comprising a claim; data that support that claim; warrants that provide a link between the data and the claim; backings that strengthen the warrants; and, finally, rebuttals which point to circumstances under which the claim would not hold true. The resulting framework of levels, shown in Table I, describes argument as increasing in quality from Level 1 to Level 5 and has been used

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

successfully as an indicator of quality and quantity of argumentation in science classroom discourse (Erduran et al, *ibid*). It would appear that this approach with its clear framework of levels could well be applied to the analysis of online discussion. Indeed Clark and Sampson (2007) have evidenced its potential in their investigation into the effectiveness of scaffolding students in personally developing scientific principles to seed online asynchronous discussions in the Web-based Inquiry Science Environment (WISE) environment.

In establishing this framework, Erduran, Simon and Osborne (2004) drew two major distinctions in quality of argumentation. The first was whether a student's argument contained any reasons, i.e. data, warrants, or backing, to substantiate their claim and the second was whether the argument contained a rebuttal. Erduran et al (*ibid*) point out that conversations containing rebuttals will always be of better quality than those without, given that the claims of individuals who engage in talk without rebuttals remain unchallenged. They suggest that this is because without rebuttals the reasons behind students' beliefs are not questioned and may simply be opposed by one or more counter-claims. Such arguments have the potential to continue forever with no change of mind and no evaluation of the quality of the substance of an argument. Furthermore, rebuttals can also be considered as a measure of conversational engagement. In other words, since one of the goals in promoting argumentation in science lessons is to engage learners in a two-way conversation where they can not only substantiate their claims but also refute others' with evidence, the presence of rebuttals in discussion can act as an indicator of sustained engagement in argumentation.

Research aims

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Therefore the current study was set up to identify:

- The opportunities that online discussion offers that can support young people learning to argue;
- How online discussion compares with face to face discussion in respect to enabling students to practise argumentation;
- The challenges and enablers that shape the opportunities offered by online discussion in UK schools today.

The quality of argument demonstrated by first year sixth formers (Year 12) studying for biology A level in schools across England in online and face to face discussions was directly compared using Erduran, Simon and Osborne's (2004) framework of five levels.

Deleted: or physics

Method

Design

The DAIS project involved a series of teaching interventions in which students used different types of discussion in sixth form science lessons. Three kinds of discussion were to be employed by each teacher: face to face in a class session, online within the teaching group (within school) and online between schools. The distinction between online within school and online between schools was made in order to explore possible differences between discussions involving participants known to each other and discussions involving known and unknown participants. In an earlier online between schools discussion the project team had observed some elements of competition between schools.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

The study used a mixed methods design to investigate the nature and extent of the discussions. Observational data were collected from audio recording of the students' face to face discussions and the students' written contributions on the online discussion board on the BEEP website. In addition, both quantitative and qualitative data were collected through student and teacher post-discussion questionnaires. These questionnaires contained both fixed choice and open-ended responses intended to elicit participants' views on student attitude toward and learning from discussion based activities in science.

Participants

An opportunity sample of six teachers as co-researchers from schools across England was recruited. Most were highly experienced as teachers with five having more than 20 years' teaching experience and all were familiar with the BEEP website and using web based activities to support their teaching. Three of the teachers came from state maintained community comprehensive schools (students aged 11-18), one from a state maintained sixth form college (students aged 16-19), one from a further education college (students aged 16 +) and one from an independent fee-paying school (students aged 11-18). The student sample comprised the above teachers' Year 12 students (aged 16-17) a total of 84 students in all. The Year 12 class sizes ranged from 8 to 26 students with a mean of 15. They were all being prepared for their Advanced (A) Level in Biology except for the students at the further education college who were studying for their International Baccalaureate. In all cases the students and teachers had access to internet enabled computers in their school that could be booked both for lessons and used outside of class time. Students were experienced users of the internet. All four schools delivered a programme of information and communications technology (ICT) skills either in line with or informed by the

Deleted: different media

English national curriculum for ICT and students at the two colleges had experience of similar programmes in their feeder schools.

Procedure

The project team aimed to collect evidence of discussions arising from actual teaching situations. In order that all the teachers started from a common understanding of what is meant by science-based discussion and levels of argument, they were invited to attend a continuing professional development (CPD) day in February 2008 at the Science Learning Centre South West, where the project team ran a workshop led by Dr Sibel Erduran on argumentation skills.

During the morning session of the workshop, materials from the Ideas, Evidence and Argument in Science (IDEAS) project (Osborne, Simon and Erduran, 2003), were used. These are intended to help teachers to learn how to structure arguments, strategies for teaching argument and how to assess the quality of argument in students' work using a scale based upon Toulmin's Argument Pattern (TAP) (Erduran, Simon and Osborne, 2004). The afternoon session was a process of co-constructing the format of the data collection jointly with the teachers. By the end of the day the teachers had planned who would work together for the between schools online discussions and they had agreed on a timetable for when topics and discussions would be tackled during the rest of the school year. The teachers agreed that they would first apply the methods of teaching argument with their class. Then following the teaching of an agreed topic, the teacher would initiate a class discussion. This would be one of three types: face to face in small groups, with a single group audio recorded at opportunity; using the BEEP discussion board for an online

Deleted: different media

discussion between members of the class or as an online discussion shared with the class from one or more participating schools.

Following each discussion, both teacher and students would complete the post-discussion questionnaires. This cycle of teaching, discussion and questionnaires was to be repeated three times, once for each of the three different types of discussion. These cycles were staged so that the different classes conducted the different types of discussion in different sequences to avoid a practice effect.

During the eight months of data collection, the project team supported and facilitated the process through regular contact with the participating teachers. Monthly newsletters were emailed out to remind the teachers of the tasks, to feed back each other's concerns as well to share the project team's observations of the process and any emerging findings. The researchers also telephoned and emailed all of the teachers regularly, to help keep track of how the tasks were being carried out and to offer any help or suggestions as required.

Materials

Each teacher was given a small handheld digital audio recorder to give to students engaged in the face to face discussions. All students were also given access to the private online discussion boards at the BEEP and its companion site PEEP (for Physics teaching, www.peep.ac.uk) websites. These are managed by phpBB bulletin board software, modified to be more school friendly and made private to remove interference from outside of school use.

Deleted: different media

Analytical approach

The audio recordings from face-to-face discussions were first transcribed to allow textual analysis along the same lines as for the online discussion. All textual contributions were analysed and scored by at least two reviewers using the framework of levels of argumentation (Erduran, Simon and Osborne, 2004) described earlier. This framework is shown in Table I below, together with the extra information that was developed by the researchers as they moderated their coding of quality of argument for this project. Moderation involved first coding two samples of each type of discussion blind and agreeing on the levels of argument assigned before the other samples were coded.

-----Table I. about here-----

Data from the teachers' post-discussion questionnaires were collated to reveal the circumstances surrounding each of the teaching/discussions exercises and assignments. These were examined for evidence to help shed light on the material supplied by students. The students' post-assignment questionnaires were collated to look for connections and themes that could in any way connect together the students' experiences of the discussions, their assignments and their use of argument.

Results

The six teachers engaged with the project to different extents with only two schools reporting back on all three types of discussion. In total 156 questionnaires were returned from 84 students. As each student was expected to complete three each this represents a response rate of 62%.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Questionnaires reporting on face to face discussions were received from 61 students, on online discussions between schools from 70 students and on online discussion within a school (within a class) from 35 students. Where teachers enabled students to participate in all 3 types of discussion 77% of their students completed all three questionnaires.

Unanticipated events in the schools affected the number of discussions completed by cutting down the time available to deliver the curriculum. Teachers viewed the discussions as additional to the set syllabus and so some, most notably the planned online within school discussion, were cut when they came under pressure. Five teachers completed post-discussion questionnaires. They took the discussions seriously and reported that they had ensured that the students were prepared for taking part. Straightforward teaching in class and setting research tasks on the BEEP and PEEP websites were the most popular methods of preparation. However, the teachers varied more widely in the extent to which they prepared students for deploying discussion and argument in science. Two reported having done little or nothing and two others focused on reminding the students about the ethical frameworks given in the Salters-Nuffield Advanced Biology (SNAB) syllabus. The teacher from College R who taught the International Baccalaureate syllabus reported discussing moral versus ethical exploration of controversial issues and what makes for a good argument as well as discussion etiquette such as respecting each other and listening as well as speaking.

The time allotted to the face to face discussions was dependent on curriculum pressures and varied according to teacher. Approaches included several 4-5 minute slots, though most were single longer sessions that ranged from 12 to 23 minutes. In two of the face to face discussions

Deleted: different media

teachers reported the discussion continuing after the lesson had finished, online in one case and face to face in the other. The amount of time teachers suggested to their students that they should spend in the online discussions varied from half an hour to a minimum of one hour. The online within school discussions took place over one to three days and the online between school discussions ranged over one to six weeks. Four teachers reported students logging onto the discussion boards from home and in three of these discussions the students also made contributions to the discussions in school but outside of class time. There was no pattern to the numbers of students participating in the different types of discussion, not all the students in the class took the opportunity to contribute online or face to face and face to face discussions took place both in whole classes and small groups.

In all, eleven discussions took place for which sufficient data was collected to enable analysis. These are listed in Table II together with the schools involved and their topics.

-----Table II. about here-----

Quality of Argument in the Different Types of Discussions

Levels of argument allotted to student contributions in the different types of discussions varied from level 2 (claims with supporting evidence but attempts to rebut others' points) to level 5 (extended argument with more than one rebuttal). Examples of the different levels are shown in Figure 1 below in an extract from an online discussion on the ethical correctness of using stem cells to create new tissue that was started off by asking students to respond to the open-ended phrase "Surely, whether this is ethically correct or not, if enabling possible cures or prolonging

Deleted: different media

life for us it is better...". Discussions were scored according to the highest level of argument achieved during the discussion. The presence of several rebuttals, as shown below, means that this complete discussion was scored at level 5.

-----Figure 1. about here-----

The results of this analysis of the quality of argument produced by students participating in all the different types of discussions recorded for this project is shown in Table III below, and indicate that, within this sample, the dialogue in online discussions demonstrated higher levels of argumentation than that in the face to face discussions.

-----Table III. about here-----

Three of the five online discussions between schools and both online discussions within school were assigned level 5 as opposed to only one of the four face to face discussions. The quality of argument was particularly strong in the online discussions within school where the mean number of posts per participant is over 2.5 in comparison with the online discussions between schools where the mean number of posts per participant ranges from 1.2 to 2.

Generally students in the face to face discussions made more but shorter utterances compared to the posts made in the online discussions; they volunteered less evidence to support their arguments and were less likely to challenge each other's points of view. Also, as shown in Figure 2 below, in the example of a face to face discussion on global warming from Independent School

Deleted: different media

C where the students were asked to debate the statement "Global warming is definitely manmade, there is no two ways about it.", it appeared that students in face to face discussions were more likely to seek consensus unless a teacher intervention redirected them with a new challenge.

------Figure 2. about here-----

Interestingly in the online discussions, patterns of student contribution varied depending on the context in which the online postings were made. Where teachers allocated class time to the project, this led to a 'scattergun' effect as students posted within seconds of each other. These postings were usually very brief and frequently did not refer to previous contributions. However, students also contributed out of class time both in school and at home. Whilst for some a single contribution was made as a homework task others, as can be seen in Figure 1 became involved in extended discussions and voluntarily posted well outside school hours. These later postings tended to be longer and more carefully considered and to engage more with previous postings. A few students even continued to check the discussion boards long after the unit of work was finished. Thus both types of online discussions clearly developed in quality over time, two discussions gained higher levels than they would otherwise have done because of interventions following the bulk of contributions made by a small group of students following up the discussion outside class time and several days after the task was set. Figure 3 illustrates part of the out of hours discussion carried out by a small group of students from College R following up a discussion on whether women should be paid for donating their eggs started by Community School N.

Deleted: different media

------Figure 3. about here------

Thus a small group of students, for example S13 and S24 who appear in both Figure 1 and Figure 3, were seen to engage persistently and voluntarily in online debate.

Students' and Teachers' Views on the Different Types of Discussions

Students and teachers were asked to rate each type of discussion as to whether they enjoyed it, learned from it or found it hard. They used a visual analogue rating scale (Aitken, 1969), a 10 cm line labelled 0 at one end and 100 on the other, to indicate how much they agreed with the given statement with 100 (indicated by an X placed on the line at 100mm) being maximum possible agreement and 0 not at all. As shown in Table IV below students reported enjoying and learning from all the discussions though there was considerable variation in their perceptions as reported by the visual analogue scale. In the standard deviation figures shown below it can be seen there was greater variation in students responses to being asked to rate how hard they found the discussions than the other two.

-----Table IV. about here-----

It appears that the group of students who participated in the online within school discussion enjoyed that slightly more than the other discussion types, assigning it a mean rating of 68.8 out of a 100. The other students preferred the face to face discussion very slightly rating it at 64.7 to the online between schools discussion (rated at 61.4). The online discussions were rated highest

Deleted: different media

for achieving learning with ratings of 75.5 and 77.2 for learning compared to 69.2 for the face to face discussion. Students also reported that they found the online discussion between schools somewhat harder than the other two types assigning it a rating of 47.5 (so not overly hard) as compared to ratings of 36.4 for the face to face discussion and 38.2 for the online discussion between schools. Table V below shows the mean ratings given by the teachers for each type of discussion.

-----Table V. about here-----

In general teachers confirmed the students' views reporting that their students learned more from the online discussions and enjoyed the face to face discussion very slightly more. However, with only five teachers carrying out the rating exercise there was a lot of variation in the results. This was particularly true with respect to the within school online discussions. However it needs to be noted that only one teacher both carried out the discussion as planned and reported on it. She also reported that her students found it harder than the other discussions.

In the event teacher intervention in the online discussions was minimal though they did offer the opportunity for the teacher to moderate the discussion at a place and time of convenience to themselves. This happened once in this project when a teacher attempted without obvious success to redirect the students' discussion one evening. In contrast teacher involvement in the face to face discussions varied from none in one discussion, through several interventions at the start to set the debate going in another to occasional contributions throughout, checking inaccurate lines of argument or suggesting alternative opinions, in the other two.

Deleted: different media

Teachers were also asked to report the factors that affected how the discussions went. The positive factors reported, taken together, highlighted that the students clearly enjoyed being involved with the discussions and with the associated research project. They said that students were particularly enthusiastic about face to face discussions. With online between school discussions it appeared that students were challenged and motivated by the opportunity to debate with other schools, though one teacher reported that some of this competition appeared to be more to do with school identity rather than intellectual debate. For both kinds of online discussions the importance of being able to read others' online contributions, and respond over a period of time, was noted.

The problems reported centred on the lack of 1:1 access to ICT as and when needed in schools, and organising the timing when discussions were to take place between schools. Also, several teachers reported that curriculum disruptions had affected the time they had available to manage this project. Lastly, with respect to face to face discussions, a lack of confidence amongst some students was reported in two of the schools, one of which suggested that this may have been influenced by the presence of the digital audio recorder. However, as shown in Table VI the majority of students reported contributing to the project discussions. There appeared to be only a slight difference between types of discussion and whether students contributed or not.

-----Table VI. about here-----

Deleted: different media

A very slightly greater proportion of students within the small group who participated in online within school discussion reported contributing to it (96%) than did for the other two types (89-90%). If students reported contributing to a discussion they were then asked to indicate whether they disagreed or agreed with various statements about the type of contributions they had made. The resulting levels of agreement are shown in the chart in Figure 4 below.

-----Figure 4. about here-----

In all types of discussion over 70% of students reported that taking part in the discussion helped them get better at arguing their point in science. Proportionately very slightly more students reported that taking part in the online discussions helped them get better at arguing their points in science (76% and 79% in online discussions compared to 72% in face to face discussions). Students were slightly more likely to report that they were able to use evidence to back up their points of view in both face to face and online within school discussions (89% and 100% compared to 81% for online between schools) and in countering another's argument (88% and 89% compared to 76% for online between schools). Proportionately more students reported contributing to the online discussions (32%-33%) only because they had been told to than for the face to face ones (20%).

Only 15 students (which is less than 10% of the sample) reported that they did not contribute to discussion. Nine of these did not contribute to an online discussion and six did not contribute to a face to face one. As shown in Figure 5 below there is little or no difference in the proportion of

Deleted: different media

students who agreed that they read others contributions online than listened to others in the face to face situation.

-----Figure 5. about here------

Overall most students (75% or more of the whole sample) felt that the quality of their discussions was good. There was little difference between the face to face and online between schools discussions with respect to students' perceptions of quality. However, all of those who participated in the within school discussion reported that it was good quality.

Students were also given the opportunity to add any comments they thought relevant to how they contributed to the discussions. Key aspects of face to face discussion reported were the enthusiasm of classmates and understanding or seeing others' perspectives. The students also noted that it helped if the discussion was structured by the teacher and planning time was made available. Not everyone wanted to share their thoughts face to face though. Comments relevant to both types of online discussion, within school and between schools, were the opportunity to take time to read and reflect on others' contributions and to do research ready for a contribution. However, the students reported that if you take too long before posting then the opportunity to make your point is lost. Some who said they were not prepared to venture opinions face to face said they would do so online and, in the case of the between schools discussions, interaction can be both helpful in stimulating discussion and problematic. For example, in the latter case, a small number of students complained about the 'netiquette' of the other students involved. Overall the between schools discussion stimulated a greater number of positive comments than other types.

Deleted: different media

Discussion

It is clear from this small scale study that all three types of discussion: online between schools, online within a school and face to face in a class were largely enjoyed by most students, who felt they learned from all of them. It can also be seen (Table III) that the quality of argument these students employed in their discussions (as assessed using Erduran, Simon and Osborne's (2004) framework of levels) was noticeably higher in the online versions. We need to be careful to note that the students following the International Baccalaureate were prepared in more depth for the use of argument in discussion than the other groups however; Level 5 argument was seen in both types of online discussion conducted by another school as well as College R.

Particular opportunities offered by the online discussions, in comparison to face to face discussion, that support young people learning to argue, centred on the students' use of the greater length of time available when the online discussion was continued over a period of several days. This supports Bonk and Graham's (2006) views on the importance of time and research by Tiene (2000) who found American college students were most positive about the asynchronous aspect of the online discussion experience he trialled alongside their ICT classes. Mayer (2003) also found that her college students reported that using online discussions increased the amount of time they spent on class objectives and that they appreciated the extra time for reflection on coursework issues. Whilst proportionately slightly more students in this study reported contributing to online discussions only because they were told to, they stated that taking part in the online discussions helped them to improve at arguing their point in science. This was confirmed by the analysis of the quality of argument with the online discussion within

Deleted: different media

school achieving level 5, the highest attainable and supports Mayer's (*ibid*) finding that, when her graduate students studying educational leadership were involved in online discussions, they exhibited more higher-order thinking in comparison to face to face discussions. The teachers in the current study also noted the importance of students being able to read others' online contributions and respond over a period of time, which occurred in both kinds of online discussions. This material aspect of online discussion enabled reflection and longer, more structured contributions especially from students when out of school. There were also instances where individuals contributed voluntarily outside school hours to the within school discussion of another school.

However, when online discussions took place in the classroom during a lesson, the larger numbers posting within a limited time led to sequences of claims and counter-claims without detailed analysis and fewer rebuttals. The discussion tended to consist mainly of one sentence contributions which showed little evidence of reading more than the previous one or two comments and postings tended to be simple responses to these. There was less evidence of reflection and thought or building up of an argument. This finding is consistent with Joiner and Jones (2003) study which also compared face to face and online discussion but amongst UK undergraduates. They found that even though their students were posting from different locations in their own time nearly 15% of the messages made in the computer-mediated communication were unconnected to the previous messages. Whereas only 3% of the utterances made in face-to-face discussion were unconnected and suggests that students were not taking account of each other's messages, just focusing on their own contributions. In the current study, the pressure of

Deleted: different media

being asked to make contributions in a single lesson may well have led to the observed 'scattergun' effect.

Comparing the two types of online discussion held in this study, the teachers reported that their students learned slightly more from the online discussion between schools, which is confirmed by the students' self reports. Level of argument was highest in the online discussions within a school. This particular type of discussion offers similar opportunities to the online between schools discussion with opportunities for reflection and developing argument over time and has an advantage in that the students know each other. They were clearly more willing to contribute to the online within schools discussion which achieved a rate of over 2.5 posts per participant in comparison with the online discussions between schools where the mean number of posts per participant ranged from 1.2 to 2. However, not all students contributed thoughtful arguments and it could be seen that the higher argumentation scores tended to be achieved when a very small number of students continued the discussion beyond the lesson in their own time, sometimes late at night. There maybe an issue of personal learning style here that would benefit from further research. It was noted though that having the debate online allowed non-contributors to learn through reading the others' points. One student reported "I find it very informative and useful to read other people's contributions before making my own." It would therefore appear that a potentially useful teaching strategy would be to provide model responses to support those students whose posts were lower in quantity and quality.

Face to face discussions were noted by the students for the enthusiasm of their peers. They reported enjoying the face to face discussions most of the three types, they are more informal, the

Deleted: different media

students know each other and don't have to read or write. The students reported learning slightly more from each other in face to face discussions despite reporting they did more research and used more science knowledge in the online discussions. These face to face discussions were particularly difficult to assess for quality of argument as there were a lot of implicit assumptions, students don't spell out what they assume their classmates know. Our recordings confirmed Wang and Woo's (2007) findings with graduate students, that when one student was making a point in a face to face discussion, the other members of the discussion group were often simultaneously making complementary remarks, comments or clarifications. Another finding from Wang and Woo's study, that students found online discussions to be more comfortable, less aggressive and offered more equal opportunities for group members to voice their opinions than face to face discussions, was confirmed in this study. The teachers reported that whilst students enjoyed face to face discussions slightly more, they (especially the less confident students) found them harder.

Conclusions

This small scale project included examples of productive online discussion and demonstrated the value of this medium for holding discussions. Whilst the study is limited, it did not, for example, control whether the different socio-scientific issues being discussed were of equal difficulty or for context including students' background knowledge of the topics which von Aufschnaiter et al (2008) show affects quality of argumentation, this is clearly worth further investigation. Students reported they learned slightly more from the online discussions than the face to face discussion and were very slightly more likely to report they learned from the online discussion between schools than the one within school, a result that was confirmed by their teachers.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

27

Deleted: different media

Higher quality of argumentation was seen in online discussions, especially those within a class. The online discussions tended to include longer, more thoughtful and better-structured comments than the face to face discussions. Online discussions, whether between schools or within a class, offered more opportunity over time for participating students to develop their reasoning, linking evidence and claims with rebuttals, than face to face discussions. Where online discussion was particularly productive, the students were at home or out of the classroom. It is concluded that this is because they had more time to think, to engage with the discussion, to question themselves and others and to find relevant research to back up their points.

The use of Erduran, Simon and Osborne's (2004) framework to assess the quality of argumentation was found to be an informative way of evaluating data of this kind. However, it proved challenging especially with the face to face discussions. In these, contributions were more likely to be incomplete, and the students were more likely to assume the others knew their evidence, so backings and warrants were less clear. This framework is a formal assessment of the quality of argument where the higher levels are founded on a student's use of rebuttals challenging the evidence provided by another student in the discussion. If a discussion does not reach level 5 as defined by this framework, it does not mean that it was not a good discussion. There were discussions where students made points and developed lines of argument, with evidence of different kinds, but which did not include rebuttals. For instance, the nature of ethical debate as opposed to scientific argument meant that in some discussions, primarily concerned with values and beliefs, the students were unlikely to challenge another participant's belief system and thus had little opportunity to develop a line of argument involving rebuttals as

Deleted: to be

Deleted: different media

envisaged by the framework. It was possible to have a good discussion where one line of argument was more appropriately opposed with a counter argument than a rebuttal. In such a case, the two sides were in opposition because they appealed to different value systems rather than questioning the validity of the other side's use of logic. This form of argument was not catered for by the Erduran scale which was developed largely though argumentation about scientific content and thus did not address values held by students during its development.

Deleted: .

Implications from this study for teaching are that an online discussion task should be set outside class to encourage students to develop their arguments over time. Students should be encouraged to read previous student comments in order to engage with the developing argument. Also they need to be shown how to back up their points with relevant research and how to pose questions to stimulate further discussion. It is interesting to note that students found open-ended tasks and discussion starters such as "Discuss the ethics of cloning" particularly difficult and responded well when interactive opinion polls were used alongside discussions.

Barriers to the use of online discussion in schools are largely curriculum based where, despite acknowledging the importance of training students in arguing their point of view as preparation for examinations, most teachers do not perceive it as important to assessed outcomes as science content knowledge. Also it proved challenging at times to arrange a mutually convenient period of time for matching curricula to enable a between schools discussion, nevertheless it was pleasing to see students from different schools voluntarily adding to other schools' discussions. Indeed students varied widely in their level of contribution to both online and face to face discussions. Some teachers reported that not all students were confident enough to speak out in

Deleted: different media

the face to face environment and in some of the online discussions there were multiple single postings. It seems that these students logged on because they were told to, made a single posting, and logged off. However, there were other students who made multiple postings, often in their own time. It is suggested that for these students, online discussions provide rich opportunities for learning. Our recommendations for further research focus on further investigation into these individual differences, what is it that makes for such extended variation in engagement with online discussions?

Deleted: ¶

Finally, we note the importance of peer groups; students responded to the enthusiasm of their peers in the face to face discussions and posted more often in the online within class discussions. The issue of students knowing one another quite well leading to implicit shared meanings, the ability to convey meaning through gesture and tone, discussion as conversation and students trying to reach a consensus, has to be carefully balanced with opportunities for competition and challenge offered by online between schools discussions.

Acknowledgements

The DAIS research team would like to gratefully acknowledge the sponsorship from Becta, the British educational communications technology agency, and the support of their co-researchers working in schools, often under somewhat trying circumstances, together with their students without whom this project would not have reached completion.

References

Aitken, R. C. B. (1969). Measurement of feeling using visual analogue scales. Proceedings of the Royal Society of Medicine, 62, 989–993.

Deleted: different media

Bonk, C. J. and Graham, C. R. ed. (2006). *Handbook of blended learning: global perspectives, local designs*. San Francisco: Pfeiffer.

Clark, D. B. and Sampson, V. D. (2007) 'Personally-Seeded Discussions to Scaffold Online Argumentation', International Journal of Science Education, 29: 3, 253 — 277

Dawson, V.M. and Venville, G. (2008). Teaching Strategies for Developing Students' Argumentation Skills About Socio-scientific Issues in High School Genetics. Research in Science Education, 40(2), 133-148.

Donnelly, J. (2004). "Ethics and the science curriculum". School Science Review, 86(315), 29-32.

Erduran, S., Ardac, D. and Yakmaci-Guzel, B. (2006). Learning to teach argumentation: Case studies of pre-service secondary science teachers. Eurasia Journal of Mathematics, Science and Technology Education, 2(2), 1-14.

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the use of Toulmin's Argument Pattern in studying science discourse. Science Education, 88(6), 915-933.

Deleted: different media

Felton, D. and Kuhn, D. (2001). The development of argumentative discourse skill. Discourse Processes 32 (2/3), 135–153.

Fleetwood J., Gracely E., Vaught W., Kassutto Z., Feldman D. & Novack D. (2000). MedEthEx Online: A computer-based learning program in medical ethics and communication skills. Teaching and Learning in Medicine, 12 (2), 96-104.

Gibson, W. (2009) 'Negotiating textual talk: conversation analysis, pedagogy and the organisation of online asynchronous discourse', British Educational Research Journal, 35: 5, 705 — 721

Hall, E. (2004). "Science and Ethics: give them a break". School Science Review, 86(315), 25-28.

Hara, N., Bonk, C. J., & Angeli, C. (2002). Content analysis of online discussion in an applied educational psychology course. Instructional Science, 28, 115-152.

Jarvela, S., & Hakkinen, P. (2000). Levels of Web-Based Discussion: Theory of Perspective-Taking as a Tool for Analyzing Interaction. In B. Fishman & S. O'Connor-Divelbiss (Eds.), Fourth International Conference of the Learning Sciences (pp. 22-26). Mahwah, NJ: Erlbaum.

Joiner, R. and Jones, S. (2003). The effects of communication medium on argumentation and the development of critical thinking. International Journal of Educational Research, 39 (8), 861-871.

Levinson R. (2003). Teaching Bioethics to Young People. In Levinson R. & Reiss M.J. (Eds.), Key Issues in Bioethics (pp. 25-38). London: RoutledgeFalmer.

Littleton, K. (1999). Productivity through Interaction: An Overview. In Littleton, K. and Light, P. (Eds.), Learning with Computers: Analysing Productive Interaction (pp. 179-194). London: Routledge.

Mellar, H. and Howell-Richardson, C. (1999) 'Techniques for analysing on-line interaction'. In Selinger, M and Pearson, J. (Eds) Telematics in Education: Trends and Issues. pp. 88-104 Oxford: Elsevier.

Meyer, K. A. (2003). Face-to-face versus threaded discussions: the role of time and higher-order thinking. Journal of Asynchronous Learning Networks, 7, 3, 55–65.

Millar, R. and Osborne, J. (1998). Beyond 2000: Science education for the future. Kings College, London. Retrieved June 26, 2009 from http://www.kcl.ac.uk/content/1/c6/01/32/03/b2000.pdf

Newton, P., Driver, R., & Osborne, J. (1999). The Place of Argumentation in the Pedagogy of School Science. International Journal of Science Education, 21(5), 553-576.

Osborne, J., Erduran, S., & Simon, S. (2004). Ideas, Evidence and Argument in Science Project. London: King's College, London.

Deleted: different media

Osborne, J.F. and Dillon, J. (2008). Science Education in Europe: Report to the Nuffield Foundation. London: King's College London

Sá, L.P. e S.L. Queiroz (2007). Promovendo a argumentação no ensino superior de química. Química Nova, 30(3), 2035-2042.

Sadler, T.D., Amirshokoohi, A., Kazempour, M. and Allspaw, K.M. (2006). Socio-science and Ethics in Science Classrooms: Teacher Perspectives and Strategies, Journal of Research in Science Teaching, 43(4), 353–376.

Sadler, T.D. and Fowler, S.R. (2006). A Threshold Model of Content Knowledge Transfer for Socio-scientific Argumentation, Science Education, 90(6), 986 – 1004.

Salmon, G. (2000). E-Moderating: The key to teaching and learning online. London: Kogan Press.

Salters-Nuffield Advanced Biology (SNAB) (2003). Examiner's Report, Edexcel, London. Retrieved May 26, 2006 from http://www.edexcel.org.uk/VirtualContent/72372/Biology_Salters_Nuffield_Examiners_report_issue.pdf

Deleted: different media

Sugrue, B. (2000) Cognitive approaches to web-based instruction. In *Computers as cognitive tools: no more walls*, ed. LaJoie, S. P. pp. 133–162. Mahwah, NJ: Lawrence Erlbaum Associates.

Tiene, D. (2000). Online discussions: a survey of advantages and disadvantages compared to face-to-face discussions. Journal of Educational Multimedia and Hypermedia, 9(4). 371–384.

Toulmin, S. (1958). The uses of argument. Cambridge: Cambridge University Press.

von Aufschnaiter, C., Erduran, S., Osborne, J. & Simon, S. (2008). Arguing to learn and learning to argue: Case studies of how students' argumentation relates to their scientific knowledge. Journal of Research in Science Teaching, 45(1), 101-131.

Wang, Q. and Woo, H. L. (2007). Comparing asynchronous online discussions and face-to-face discussions in a classroom setting. British Journal of Educational Technology, 38(2), 272–286.

Wellcome Trust (2003). Engaging Science: Society Awards. Retrieved November 15, 2003 from http://www.wellcome.ac.uk/en/1/pinpubscisoc.html

Zeidler, D. and Keefer, M. (2003). The role of moral reasoning and status of scientific issues in science education. In Zeidler, D. (Ed.), The role of moral reasoning and discourse on socioscientific issues in science education (pp.7-40). Dordrecht: Kluwer Academic Publishers.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Table I. Levels of Argument

Level	Further explanation
Level 1 argumentation consists of arguments that are a simple claim versus a counter-claim or a claim versus a claim.	No supporting evidence supplied
Level 2 argumentation has arguments consisting of a claim versus a claim with data, warrants, or backings but do not contain any rebuttals.	Supporting evidence supplied for claims but no rebuttals. A rebuttal is a challenge to other claimants' evidence (backings) or logic (warrants)
Level 3 argumentation has arguments with a series of claims or counter-claims with either data, warrants, or backings with the occasional weak rebuttal.	As Level 2 plus weak (unsupported by science) challenge on other claimants' evidence or logic
Level 4 argumentation shows arguments with a claim with a clearly identifiable rebuttal. Such an argument may have several claims and counter-claims.	As Level 2 plus clearly identifiable challenge on other claimants' evidence or logic
Level 5 argumentation displays an extended argument with more than one clear rebuttal	More than one well supported challenge made.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Table II. Discussion types, participants and topics

TYPE	TOPIC	PARTICIPANTS
Face to face	DNA Fingerprinting	Community School C
	Ethics of cloning	College R
	Global warming	Independent School C
	Genetic Testing	College G
Online between schools	Human Cloning	Community School N, College G
	Ethical correctness of using stem cells	Community School N, College G, Independent School C, College R
	Stem cells in use	College G, Community School N, Independent School C
	Paying women for egg donation	Community School N, College R
	DNA Fingerprinting and the National DNA data base	Community School C and College R
Online within school	Genetic engineering of crops	Community School N
	Genetically Modified Organisms	College R
	DNA Fingerprinting and the National DNA data base[1]	Community School C

[1] This discussion was not used in further analysis as the teacher reported it had been seriously affected by last minute timetable changes in school.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Table III. Quality of Argument found in the different types of discussions

Type of Discussion	Highest Level of Argument Achieved	Length of discussion (Time taken (F2F) or no. of posts (online))	No. of participants in the discussion	No. of participating schools
Face to face	Level 5	18 mins	5	1
	Level 3	16 mins	4	1
	Level 4	12 mins	5	1
	Level 3	23 mins	5 - 9	1
Online between schools	Level 5	55 posts	28	2
	Level 5	22 posts	19	4
	Level 2	15 posts	11	3
	Level 4	13 posts	11	2
	Level 5	44 posts	28	2
Online within school	Level 5	61 posts	21	1
	Level 5	44 posts	16	1

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Table IV. Mean rating (out of 100) by students of enjoyment in, learning from and difficulty with the different types of discussions with standard deviation (in parentheses).

	I enjoyed it	I learned from it	I found it hard
Face to face (n=57)	64.7 (21.3)	69.2 (19.8)	36.4 (26.3)
Online between schools (n=68)	61.4 (22.3)	77.2 (21.4)	47.5 (27.1)
Online within school (=24)	68.8 (20.5)	75.5 (20.7)	38.2 (24.5)

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Table V. Mean rating (out of 100) by teachers of students' apparent enjoyment in, learning from and difficulty with the different types of discussions

	Students enjoyed it	Students learned from it	Students found it hard
Face to face (n=4)	76	65.5	50
Online between schools (n=5)	73.8	71.6	35.2
Online within school (n=2)	68	86	86

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Table VI. Numbers of students reporting whether they contributed by discussion type

	Face to Face	Online_between	Online-within
Number reporting they didn't contribute	6 (10%)	8 (11%)	1 (4%)
Number reporting they contributed	55 (90%)	62 (89%)	24 (96%)
Total	61	70	25

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Figure 1. Exemplar short extract[2] from an online between schools discussion on the ethics of using embryonic stem cells

Wed 18:30	S13: Wether or not you believe that an embryo at the totipotentic stage has human rights or not is up to personal opinion. *<level 1 claim>* However the fact that people think it's a life and is important the opinions of others count greatly and especially in a topic such as this one. Who knows what those 8 cells could become who know's what those 8 cells can achieve you don't, therefore you should wait and see rather then experiement on it. *<level 2 claim with warrant>*
Thu 19:13	S24: Well, it depends whether said embryo is actually inside a mother, many embryos kept in fertilisation clinics will never be used to impregnate anyone, *<level 4 (clear rebuttal)>* and therefore cannot grow at all, no matter what stage they're at. Of course, the majority of abortions in England and Wales (over 80%) are either at or before 12 weeks (the legal limit is twice that), which is a month after the embryo has become a fetus. *<level 2 claim (includes evidence)>* If we are fine with this destruction of an older being, then why not the less developed embryo? *<level 4 (clear rebuttal)>*
Thu 22:56	S26: There is always the question of who has the right to decide about any human being beign killed. Whether two weeks old or older it can be considered as limiting the freedom to live. *< level 1 claim>* Nevertheless it is worth thinking about the fact that the mother is at that point responsible for the child and some might argue has the power to decide these things!
Sat 09:58	S14: Even if a Human Blastocyst has the potential to grow into a fully-fledged human i don't believe we should consider a Blastocyst a human and give it human rights anymore than we give a cell human rights. *<level 2 counterclaim (includes scientific rationale)>* But i can still see the problems people might have with that *<level 3 weak rebuttal>*so i think we also have to determine whether there are alternatives to obtaining stem cells from blastocysts, such as from adult stem cells that would yield similar benefits at lower cost, including lower ethical and symbolic costs. *<level 2 claim (includes evidence)>*
Sun 12:03	S7: S24 wrote: "Well, it depends whether said embryo is actually inside a mother, many embryos kept in fertilisation clinics will never be used to impregnate anyone, and therefore cannot grow at all, no matter what stage they're at." Thats a really good point. As there are so many embryos discarded at IVF clinics when couples no longer need them, *<level 3 weak rebuttal>* I think people should be persuaded to donate the unused embryos to stem cell research in the hope that it could prolong the lives of others rather than simply dispose of the potential life of the embryo *<level 2 claim (includes rationale)>*

[2] Presented exactly as written

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Figure 2. Exemplar extract from a face to face discussion on causes of global warming

M1	Well we have to understand it's not just carbon dioxide, it's also methane. There's more methane that's (inaudible) than carbon dioxide. *<level 2 claim (includes evidence)>*
G1	And sulphur dioxide, is that ….?
M2	No nitrous oxide.
M3	So basically if we didn't use as much fossil fuels global warming would not increase as fast as it has … *<level 2 claim (includes evidence)>*
M?	But it would still happen.
G1	But that relies on that idea that carbon dioxide is contribut (inaudible) *<level 4 (clear rebuttal)>*
M1	Most of the carbon dioxide and the methane, most of the rise in it started in industrial revolution
G1	Like it coincided with.
M1	Because of burning fossil fuels. *<level 2 claim (includes evidence)>*
M2	Um … so … are we all in agreement that global warming isn't manmade, but man sped up the rate of it?
Several	Yeah.

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Figure 3. Extract[3] from an online discussion on egg donation carried on outside class time

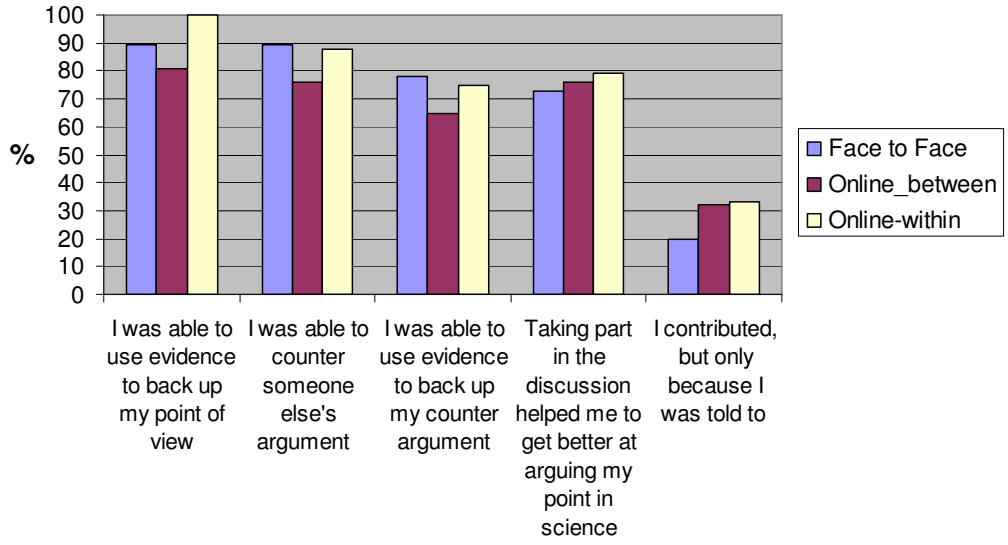
Wed 6:24 pm	S13: If the woman is fully aware of what she is about to do and told exaclty what her eggs will be used for then i think it is her natural right to do as she pleases with her eggs and if that involves getting paid then what's the harm.
Wed 10:04pm	S9: providing there is consent, it's not that different from paying guys to donate sperm to fertility clinics. slightly different circumstances but still similar concept.
Wed 10:45pm	S1: The participant would need to be interviewed and her reasons for wanting to give away her eggs would need to be satisfactory. If she is not a homeless smack addict there shouldn't really be much of a problem in giving them a few bob.
Thu 6:43 pm	S24: Even so, if she really needs the money there should be nothing stopping her, if she is aware of what the procedure and anything else she needs to know.
Thu 8:22 pm	S2: I think that a womens eggs should definately be given for research purposes, however I believe that the donor should be fully aware of what happens to her eggs before she gives any type of consent. However in response to whether women should be paid to donote their eggs, I do not believe that they should, partly becaue its sounds too much like selling body parts which can lead to all sorts of ethical and moral issues. We don't espect to be paid for something like blood which has a similar concept!
Thu 8:43 pm	S24: Actually, in many countries people are compensated for donating blood, and many countries have began stopping the payed donations purely as the paid donations are more likely to be infected.

[3] Presented exactly as written

Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Figure 4. Students' assessment of type of contributions they made shown by type of discussion (% of students agreeing with a statement is shown in each case).



Discussing ethical issues in school science: an investigation into the opportunities to practise and develop arguments offered by online and face to face discussions.

Deleted: different media

Figure 5. Students' reasons for not contributing shown by type of discussion (frequency shown in each case).