Chapter 8

"I really get this module!" Using Online Discussion Boards to Enhance Students' Understanding of Global Climate Change

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Abstract

This chapter discusses how asynchronous discussion boards may enhance undergraduate students' understanding of the contribution of palaeoclimate research to climate prediction and climate policy. As an area of troublesome knowledge containing threshold concepts, climate change requires students to practice higher-order cognitive skills. The research reported here shows that this is strongly facilitated by progression along the affective and interpersonal domains. Discourse and knowledge construction within small online groups helped many students to cross knowledge thresholds, and to become more active contributors and negotiators. The exercise also impacted positively on their motivation and confidence, helping them to sustain the effort required for deep learning.

Introduction

The use of technology to aid geography teaching and learning in higher education has become common practice (Knight, 2006; Fletcher *et al*., 2007; Lynch *et al*., 2008). Many benefits have been hypothesized concerning the impact such technology can have on teaching and learning, including enhancement of student collaboration, communication, knowledge construction, critical thinking, technical skills and intrinsic motivation (Rich *et al*., 2000; Seale and Cann, 2000; Reed and Mitchell, 2001; Skinner, 2007). However, there is relatively little empirical support for such claims and '*the pedagogic considerations of e-learning require greater attention*' (France and Fletcher, 2007, p. 5).

This chapter reflects upon the use of asynchronous online discussion boards to teach climate change science and policy to final-year undergraduate physical geography students at UWE, Bristol. In particular, the research herein aims to examine whether the adoption of this technology can enhance the student learning experience in terms of:

- promoting deep learning (Marton and Säljö, 1976) (e.g. conceptual understanding, evaluation, reflection, discursive interaction);
- improving motivation and shaping attitudes and values with respect to the subject matter.

The points above imply that a comprehensive understanding of the learning utility of online discussion boards requires examination of cognitive, affective and inter-personal learning domains. The cognitive domain is knowledge or mind-based (Bloom *et al*., 1956), whereas the affective domain concerns students' personal relationships and value systems, involving constructs such as attitudes, values, opinions and motivations (Krathwohl *et al*., 1964). The inter-personal domain concerns building relationships and interacting positively with others (Vaughan, 1980). It moves students from passive recipients of information to more active contributors and negotiators (Table 8.1). The research presented here examines all three domains, adopting a constructivist pedagogical strategy, mediated via ICT, and acknowledging a number of related approaches to teaching and learning.

Cognitive	Affective	Inter-personal
Knowledge	Receiving	Seeking/giving information
Comprehension	Responding	Proposing
Application	Valuing	Building and supporting
Analysis	Organisation	Shutting out/bringing in
Synthesis	Characterisation	Disagreeing
Evaluation	-	Summarising

Table 8.1 The three learning domains examined in this research.

The chapter begins with a pedagogic rationale for discussion boards within the context of climate change science, and specifically their potential to assist in the exploration of threshold concepts and troublesome knowledge. The context of the host module is described briefly along with the methods utilised to both establish and manage the online discussions and to elucidate student responses. The content of the online discussion boards, students' written coursework, and questionnaire responses are used to evaluate learning in the domains described above. Reflection on the exercise identifies recommendations for, and potential improvements to the approach, with reference to pedagogy and logistics.

Climate Change – Pedagogic Challenges Posed by Uncertainty and Complexity

The science of global climate change is inherently complicated (Gautier and Rebich, 2005; Rebich and Gautier, 2005) and thereby presents a significant pedagogic challenge to the teacher and student. To place climate change impacts, mitigation and adaptation into context requires comprehensive understanding of complex cause and effect. This in turn demands competent knowledge of spatial and temporal dynamism, often involving non-linear relationships between system elements, and positive and negative feedbacks (Alley *et al*., 2003). There may also be deterministic and stochastic components that influence system stability (Alley *et al*., 2003; Herbert, 2006) and which may be a cause of abrupt climate change in the future (Alley *et al*., 2003). Their understanding is crucial in order to predict future system behaviour in a variety of scenarios.

Additionally, cognitive limitations create difficulties in conceptualising complexity in the Earth system and in linking this to environmental policy (Herbert, 2006). This complexity introduces students to threshold concepts - key ideas in a discipline that offer the learner a gateway into new ways of thinking (Meyer and Land, 2006) - making climate change an area of troublesome knowledge (Perkins, 1999). The characteristics of threshold concepts in the context of this study are outlined in Table 8.2.

Table 8.2 Characteristics of threshold concepts (Meyer and Land, 2006) in the context of this study.

Characteristics of threshold concepts	Examples in this study
Transformative	Changing the way in which students perceive the contribution of palaeoclimate to climate prediction and policy
Irreversible	Understanding the concept of "reverse uniformitarianism"[1] and its application to prediction and policy
Integrative	Relating scholarly work in palaeoclimate to climate modelling and climate policy
Bounded	Helping to define the boundaries of elements within the Earth system
Troublesome	Linking feedbacks in the palaeo Earth system to future climate behaviour

The conceptualisation difficulties associated with future climate change have been tackled predominantly by inquiry-based learning utilised in class discussions (e.g. group role-play and student-led teaching; Hughes, 2008) and online by various means (e.g. collaborative group Blogs - Hughes, 2008 - and Wikis - Walton, 2006). Inquiry-based learning helps students to examine uncertainty in the broader context of science, and to explore troublesome knowledge (Perkins, 1999). This form of learning is essentially question-driven, involving active, student-centred learning, mediated by the tutor guiding and encouraging students through the inquiry process (Spronken-Smith *et al*., 2008).

Communities of Discourse and Constructivism

Online discussion forums have the potential to build climate change knowledge via inquiry-based, collaborative learning, the latter characterised by students working in small groups to reach a common goal (Yarnal and Neff, 2007). Within such communities, knowledge and experience are shared via electronic conversation within which alternative viewpoints and perspectives are negotiated. Such activity can promote reflection on course material, reflection being 'those intellectual and affective activities in which individuals engage and explore their experiences in order to lead to new understandings and appreciations' (Boud *et al*., 1985, p. 19). Through the process of negotiated reflection about climate change, students can ultimately revise existing knowledge to create new meaning (see Mason, 1998; Mason and Santi, 1998; Rebich and Gautier,

[1]An extension of Lyell's paradigm of uniformitarianism that suggests that the key to present environmental conditions may be found in past environments.

2005; Andonova and Mendoza-Castro, 2008), becoming critical reflective thinkers who are able to play an active role in adapting to changing circumstances and in organising considered and appropriate responses (Harvey and Knight, 1996).

Negotiated reflection adheres to the idea of the interdependence of individual and interactive processes in the co-construction of knowledge (John-Steiner and Mahn, 1996) and, ultimately, to the social construction of knowledge (Bruner, 1990; Driver *et al*., 1994; Bardsley and Bardsley, 2007). There has been recent research by geographers (and others) concerning the use of technology for collaborative learning (see Reed and Mitchell, 2001; Skinner, 2007). However, there is a need for better understanding of online student discourse (Liu and Tsai, 2008), particularly in relation to the nature and quality of student discussion (Wallace, 2003; Skinner, 2007). In the study reported here, small groups of individuals worked together collaboratively in real world enquiry, integrating new knowledge with prior knowledge via research and discussion (Laurillard, 1993; 1997).

Collaborative learning in asynchronous environments has been shown to impact upon understanding. Students move up the hierarchy of cognitive learning, helping them to evaluate material, make judgements and reflect (Hara *et al*., 2000; Seale and Cann, 2000; Schellens and Valcke, 2005; 2006; Skinner, 2007). Furthermore, as technology is adopted within courses, new relationships are emerging between teacher and learner. Firstly, the teacher must enable students to make technological applications work for them. Secondly, in order to promote self-learning and self-reliance amongst the students, the teacher must scaffold the student learning experience throughout the duration of the activity, by way of clear guidance to ensure collaboration and enhanced learning (Reed and Mitchell, 2001; Anderson *et al*., 2001). The teacher moves from the role of expert transmitting information to a more indirect manager and facilitator (McNeil *et al*., 2000; Mazzolini and Maddison, 2003; Liu and Tsai, 2008).

Context of the Study

At UWE Bristol, students on BSc Geography and Environmental Management may follow a routeway in global climate change. Within this, they encounter troublesome knowledge in a range of contexts (including interpretation of palaeoenvironmental field and laboratory data) and they tackle this using methodological approaches taught to them by staff. This begins at level 4 with the core module ‘Earth Systems’, which builds a broad knowledge of Earth System Science (*sensu* Kump *et al*., 2004). At level 5, ‘climate change: Tracing the Record’ focuses on Quaternary climate change, providing the geological timescale necessary for evaluating recent climate and environmental change. This is a pre-requisite module for the level 6 option ‘Global Warming and Environmental Change’.

The over-arching aim of ‘Global Warming and Environmental Change’ is to critically evaluate the future global and regional environmental changes that are expected consequences of the enhanced greenhouse effect. The module investigates the complexity of feedbacks between elements of the Earth’s system (the hydrosphere, atmosphere, lithosphere, biosphere and cryosphere) that constrain predictions of future climate and environmental change. It also evaluates current research into impact mitigation and response strategies to key meteorological and biological hazards generated by the predicted environmental changes. The module is taught via a 2½-hour contact session each week, usually consisting of a 1-hour interactive lecture and a 1½-hour student-centred practical. The module is assessed by coursework that is comprised of two elements: the students' individual contribution to an online discussion board (25% of the module grade), an individual reflective report based on the material from the online discussion board (25%), and an end-of-module examination (50%). Students submit their individual report at the end of the first semester.

One of the pedagogic challenges of the module for staff is to help students apply their palaeoenvironmental knowledge to predictions of future climate change and climate change policy. Experiences with the module's previous cohort of students who had followed a more traditional assessment format of an independent 3,000-word essay showed that, whilst many could superficially describe some of the more common areas of complexity and uncertainty associated with climate change, some still experienced difficulty in articulating climate science and its application to policy. They also struggled with the volume of peer-reviewed material, fitting a model of passive, transmissive learning, rather than transformatory learning. They needed to practice more sophisticated skills of information literacy such as locating, evaluating, analysing, synthesising and applying material (Peake *et al.*, 2005). Additionally, the students' increasing use of electronic social networking to discuss coursework led the teaching team to investigate this as a complement to individual knowledge construction.

The online discussion focused on the use of the Younger Dryas stadial[2] as an analogue for abrupt climate change and its application to climate change policy. It is a well-researched palaeoclimate event whose onset is somewhat contested; it demonstrates complexity of feedbacks in the Earth system; it has been used to validate the accuracy of climate prediction models; and it is referred to in policy-relevant documents (e.g. IPCC, 2007). A disadvantage is that the exercise revisited an event studied at level 5, which students may have perceived as repetitive.

The coursework (Figure 8.1) was part collaborative learning (using online discussion boards) and part traditional independent learning (an individual report). The collaborative approach aimed to facilitate development of the higher-order skill of critical thinking by synthesizing information and applying factual knowledge and concepts to complex, real-world situations (Harvey and Knight, 1996; Yarnal and Neff, 2007); in this case the application of palaeoclimate knowledge to climate modelling and climate policies. Via the discussion boards, the group would build an archive of peer-reviewed material that each student could utilise for their individual report. This might overcome some of the difficulties posed by a rapidly expanding subject area. Within their individual report, students were permitted to use *only* those references that had been posted to the board.

[2]A geologically brief period of abrupt climate cooling, which began ca. 12,800 years before present. Temperatures rapidly reverted to near pre-Younger Dryas levels about 11,600 years before present.

Figure 8.1 Excerpt from the coursework brief showing the structure and rationale for the pedagogic approach and use of the Younger Dryas as a case study.

UBGLQ7-20-3 Global Warming & Environmental Change
Assessed Coursework 2009-10

1. Introduction

Your coursework for this module is a critical evaluation of how research into abrupt climate change at the onset of the Younger Dryas stadial (ca. 12.8kaBP) may inform scenarios of future climate change associated with the enhanced greenhouse effect. The assessment requires you to:

- clearly and succinctly identify the climate characteristics of the Younger Dryas stadial based on palaeoclimate data (this may include a brief appraisal of the quality of proxy evidence; you do not need to detail environmental - e.g. vegetation - changes)
- critically review current palaeoclimate research into the cause(s) of the onset of the Younger Dryas stadial (you are not required to explain the termination of the event). This should include current levels of understanding of triggers, amplifiers, thresholds, and feedbacks between elements of the Earth system
- explain how the palaeoclimate research in (b) informs climate prediction models
- critically assess the contribution of this research to future global climate change policy initiatives

The coursework consists of two tasks; each equivalent to 1500 words and contributing 50% to your grade:

- contributing constructively to a group discussion board on Blackboard VLE. This will build a shared archive of critically evaluated peer-reviewed material relating to points (a) to (d) above
- writing an individual report which reflects on the contested nature of Quaternary climate science and its contribution to climate prediction modelling and emerging climate change policies

2. Why adopt this approach to the coursework?

- online discussion forums and blogs are becoming increasingly common in the area of climate change. They are likely to proliferate further during preparations for the United Nations Framework Convention on Climate Change (UNFCCC) COP15 meeting in Copenhagen in December 2009
- you are able to practice academic writing and debate in a public setting; you may be asked to do this by your employer or a group that you represent in the future!
- you benefit from an interactive, collaborative approach, sharing ideas and sustaining academic debates about peer-reviewed material

3. Why select the onset of the Younger Dryas stadial as the case study?

The feedbacks between components of the Earth system, and the triggers and amplifiers for abrupt climate change that characterised the onset of the Younger Dryas stadial, may not behave in the same way under anthropogenic warming. Researchers must therefore understand fully and be able to model accurately the natural causes of abrupt climate change before they can model the future effects of anthropogenic forcing.

Methods

Although not a deliberate intention, the exercise coincided with preparations for the United Nations COP15 meeting in Copenhagen, Denmark in December 2009, during which the complexity and uncertainties of climate change knowledge were discussed widely in peer-reviewed and popular media. The timing was serendipitous in providing a unique opportunity for the tutor and students to reflect on the wider application and relevance of their studies, and to identify the interpretation and responses to scientific uncertainty in the political arena.

The module cohort (n=24) was divided into six groups, each comprising four members. Small groups were deliberately chosen to facilitate collaborative knowledge construction (Schellens and Valcke, 2006). The groups were self-selecting, based around existing friendships. A closed asynchronous discussion board was established for each group on the Blackboard 9.0 virtual learning environment (Blackboard Inc., 2009) and remained open for four weeks. Each group's board contained four separate discussion threads, matching the structural elements (a) to (d) of the coursework brief (Figure 8.1). These sequenced tasks guided the discussion, following Davidson-Shivers *et al*. (2001) who noted that this tends to move students away from simple reacting statements to more meaningful responses. At the beginning of the exercise the rationale and rules of engagement (Salmon, 2000; Seale and Cann, 2000; Skinner, 2007) were explained to the group. Every week, each member of the group would contribute two posts, each approximately 200 words, to the group board. These postings could be to any of the discussion threads, although students generally followed tutor advice to complete earlier threads before moving on to later ones so that they built up the necessary pre-requisite knowledge. The tutor offered encouragement, guidance and adaptive feedback (see Anderson *et al*., 2001) on a weekly basis via e-mail to each group. This allowed the tutor to check that peer-reviewed material was being reported and interpreted accurately, and to check that the science was being understood correctly. At the end of the exercise each individual student was required to produce a 1,500-word report that reflected on the contested nature of quaternary science, and the application of palaeoclimate studies to future climate model and policy developments. The elements were assessed against criteria circulated to the students at the beginning of the exercise.

At the end of the exercise, students were invited to complete a short questionnaire to reflect on their experiences. The questions ascertained their perceived knowledge and confidence in the topic prior to the exercise, their experiences of using the discussion board, and their perceptions of the influence of the discussion board on their knowledge, learning, confidence, motivation and attitudes. For the majority of the questions students were guided in their responses via pre-prepared statements with tick boxes, with the opportunity for them to add additional comments for every question.

Results

Only 12% of the module cohort had previously contributed to a discussion board; nevertheless, this did not deter the majority of the students from engaging with the technology from the outset. Twenty of the twenty-four students posted to the discussion board twice each week, as instructed. Of the remaining four students, three joined the evolving group discussions in week two and one in week three. All students initially experienced problems in settling into the discussion board postings, so the exercise was extended by one week to enable them to catch up. Seventeen of the twenty-four students completed the questionnaire. All students submitted an individual report. Summary statistics for the students' grades for the two elements are shown in Table 8.3

	Discussion board	Individual report
Highest mark	72	77
Lowest mark	48	42
Average	61.1	60.3
Standard deviation	6.1	7.8

Table 8.3 Students' percentage grades and summary statistics for the discussion board and the individual report (n=24).

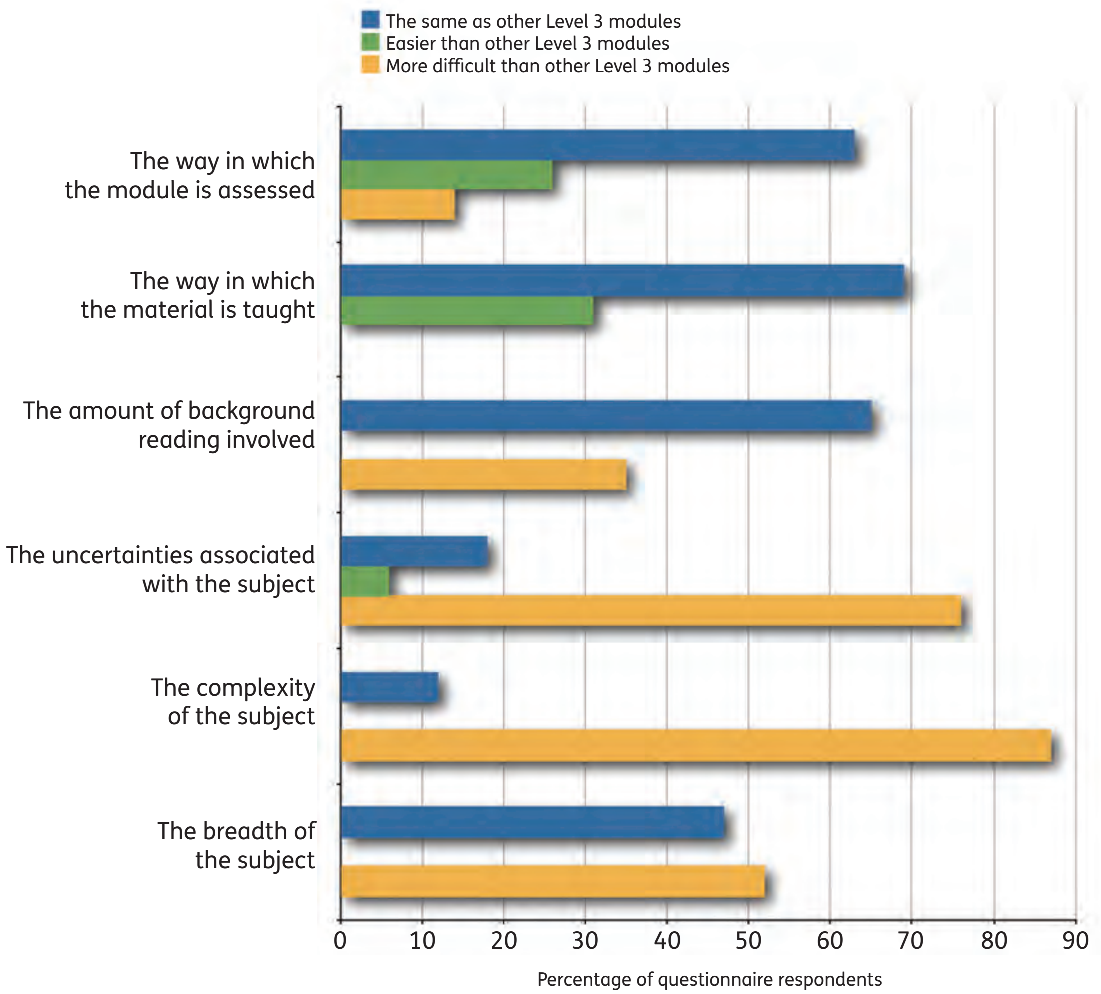
The outcomes for the research are evaluated below according to the three learning domains (Table 8.1). The evaluations are substantiated by evidence from the group discussion boards, the contents of the individual reports, students' grades and the students' responses to the questionnaire.

1. Advancing Students Along the Cognitive Hierarchy

Tackling Troublesome and Contested Knowledge

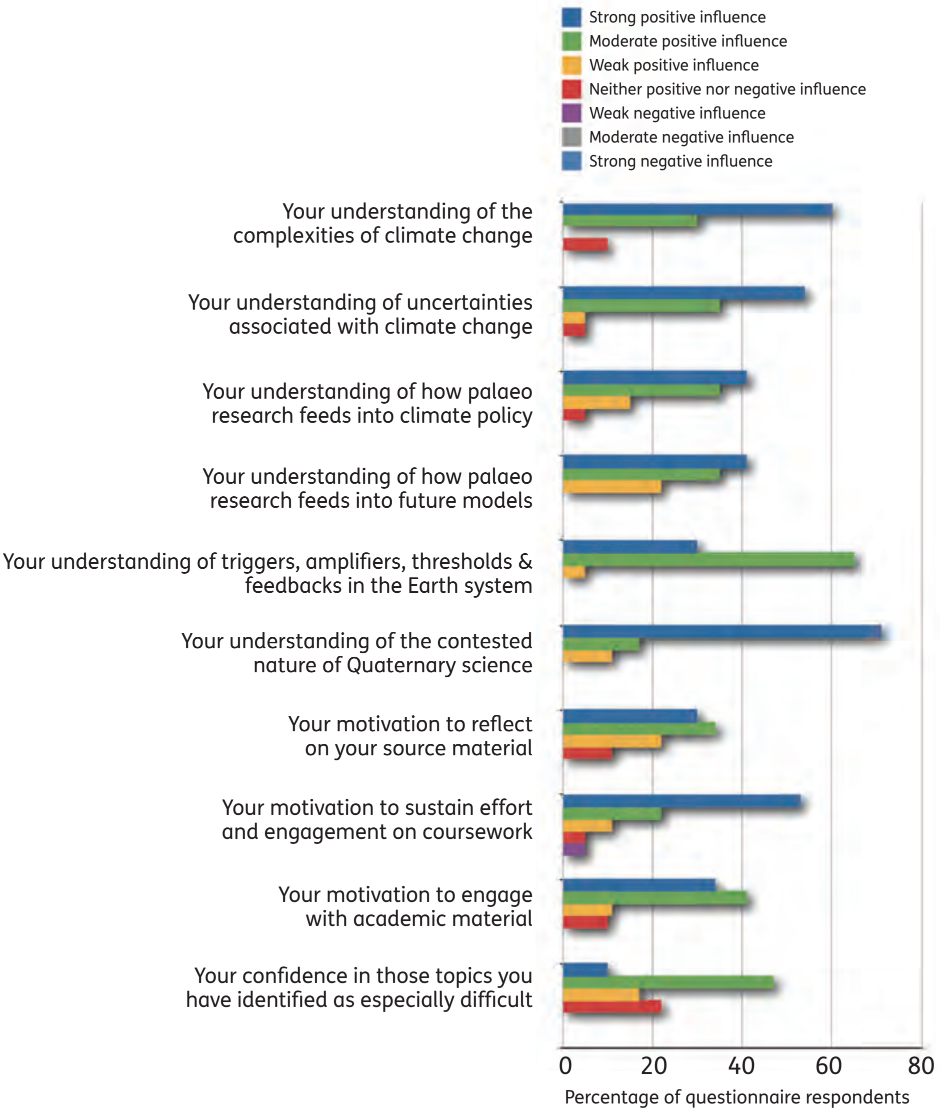
When asked about the most difficult aspects of the module compared to other level 6 modules, students recognised the uncertainties, complexity, breadth of the subject, and amount of background reading involved (Figure 8.2) (Gautier and Rebich, 2005; Rebich and Gautier, 2005). The way in which the subject matter was taught and assessed was thought by the majority to make the module about the same or easier than other modules. Thus the adoption of the technology was not perceived by the students to detract from the subject matter.

Figure 8.2 "Thinking about the subject matter of the module, which of the following makes Global Warming and Environmental Change more difficult, easier or about the same as your other level 6 modules?"



Student responses to the questionnaire indicated that the group learning had a strong positive influence on understanding the contested nature of the subject matter (70.6% of the cohort), and on understanding the complexities (58.8%) and uncertainties (52.9%) associated with climate change (Figure 8.3). Agreeing with the tentative findings of Seale and Cann (2000) and Skinner (2007), the students articulated an increase in cognitive depth from knowledge to critical reflection (sensu Boud *et al*., 1985) and evaluation:

Figure 8.3 "Did the collaboration in small groups on the discussion boards have any impact on the following areas?" Note that in the statements, 'understanding' is associated with the cognitive domain, while 'motivation' and 'confidence' relate to the affective domain.



"The use of the discussion board allowed me to reflect on some of the more difficult concepts 'in the spotlight' and subject to refute. It placed pressure upon the real understanding and not simply regurgitation of the science."

This movement along the cognitive hierarchy came from personal research, particularly reviewing literature on the subject:

"***Wider reading has enabled me to explore many more options and different opinions on the subject.***"

Additionally, a number of students through their comments evidenced a negotiated discourse that allowed them to clarify ideas, and reflect upon a broader base of material than they would have gained individually:

"***Drawing from the background reading of 5 people instead of one has allowed for an extensive reflection on previous work in the subject area.***"

The necessity to interact with other students online prompted concise and clear communication of their ideas (Reed and Mitchell, 2001); a process which some students identified as raising their performance:

"***I needed to be sure that what I posted was relevant, succinct and containing enough information.***"

"***To ensure the others in my group could understand me I felt I needed better understanding of the subject so I could put my point across fully and clearly. So in a sense the work forced me to work to a higher standard each week.***"

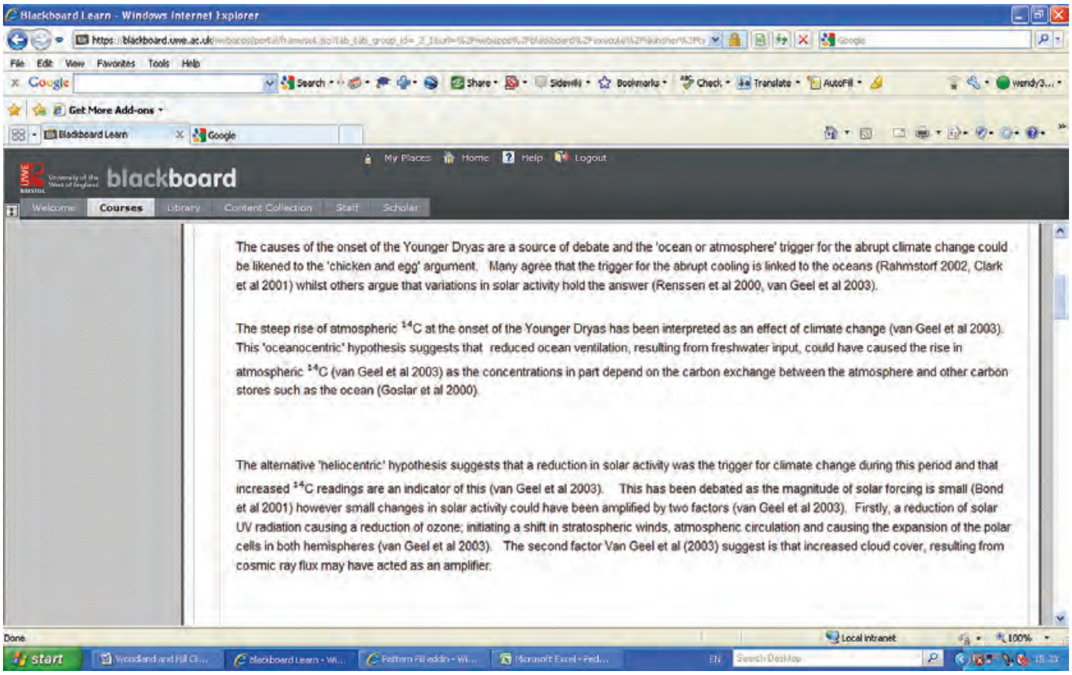
In their individual reports the top students also progressed beyond a description of the uncertainties in climate change to explain their significance to climate prediction and policy, referring to the feedbacks and system instabilities that might result if thresholds for greenhouse gas emissions and global mean surface temperature (GMST) are breached in the future.

From a tutor's viewpoint, the use of the Younger Dryas as a case study was successful because it allowed students to interrogate deeply contested academic knowledge. Students encountered this, for example, during their reading:

"***Each paper seems to express their conclusion with high levels of confidence, yet another paper can disagree completely.***"

On the discussion boards and in their individual reports, most of the cohort could identify competing theories for climate change. An example of this is the posting in Figure 8.4, which also demonstrates higher-order academic skills (synthesis, evaluation, integration). This was the only student who identified heliocentric and oceanocentric theories for the Younger Dryas stadial and who acknowledged the complexity involved in attributing cause and effect.

Figure 8.4 Screen-grab from one group's online discussion board showing higher-order academic skills of synthesis, evaluation and integration of source materials.



Not all students were able to reach the higher levels of the cognitive hierarchy, equating volume of information with volume of knowledge:

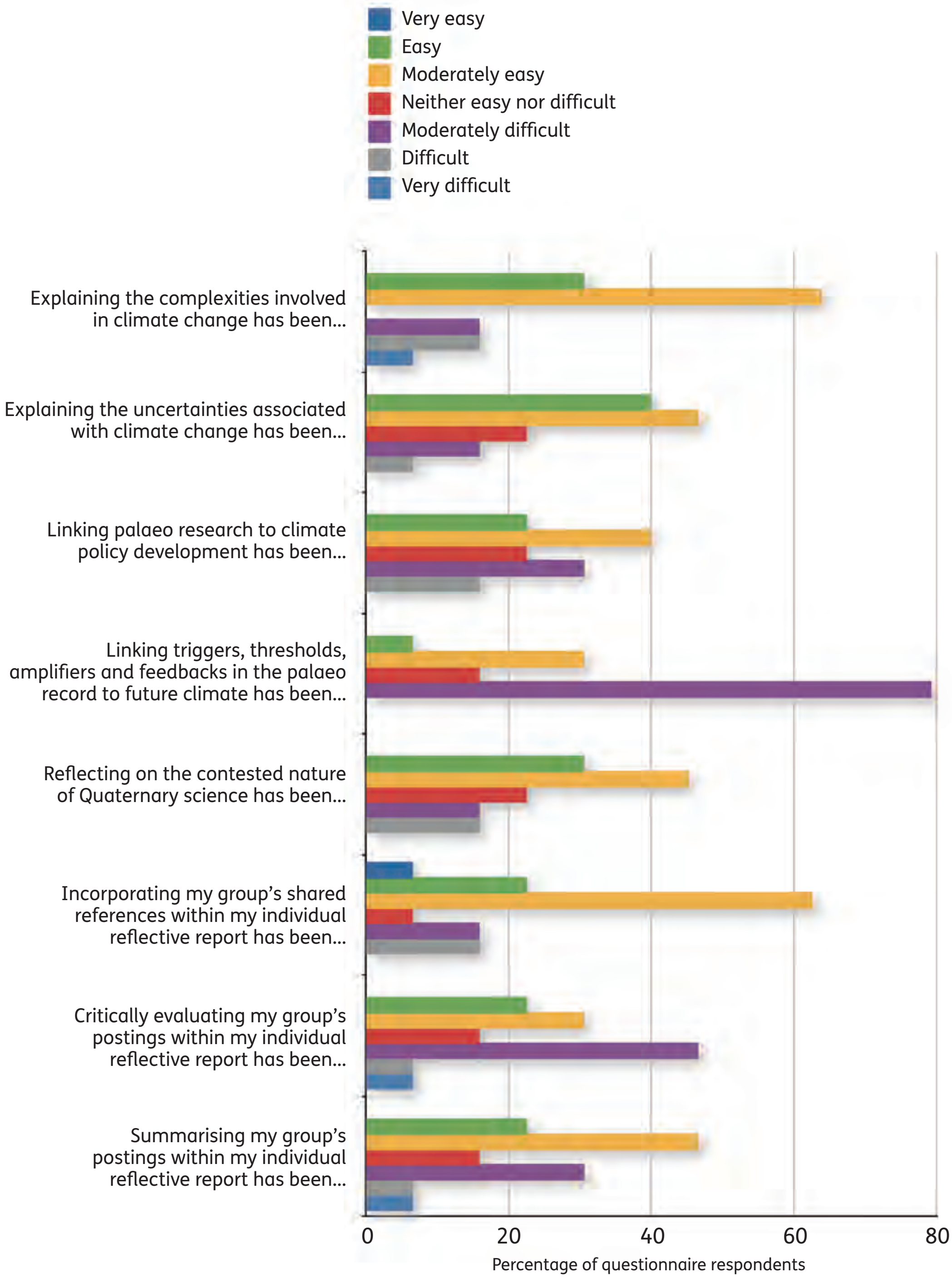
"***Due to continued reading over a period of a month, I feel I collated a vast amount of sources and references. I therefore accumulated a large amount of information about the complexities and uncertainties associated with climate change.***"

However, this student was not able to articulate understanding within their individual report, gaining a 2:2 grade.

Comprehending Climate Change Science and Relating it to Policy

Over half the cohort (58.8%) reported difficulties in linking triggers, thresholds, amplifiers and feedbacks in the Earth system (Figure 8.5), although 70.6% thought that explaining the complexities involved in climate change had been easy or moderately easy. This is difficult to reconcile because explaining complexities requires the links to be made, suggesting connections in students' mental models may not be fully recognised.

Figure 8.5 "What has been your experience while writing the individual reflective report?"



A student's open response on the questionnaire indicated the fundamental pedagogic challenge to show how a comprehension of the past can inform the future:

"***Initially confused as to why, after doing Tracing the Record last year, we were doing the past. Again***."

Linking palaeo-studies to climate prediction, and climate change science to policy remained a difficulty throughout the exercise for the weaker students (<55% overall grade). This was evidenced by their discussion board postings and individual reports, which frequently charted the history of climate policy developments such as Kyoto, without indicating how emissions targets had been informed by climate science. They needed tutor direction towards the links, suggesting difficulty in making mental models that would link past and future climate and Earth system behaviour. Some of these same students took their lead from the popular media rather than from peer-reviewed material:

"***Feedbacks - gradually easier; triggers and mechanisms under anthropogenic forcing - difficult (uncertainties); hard to mesh policy decisions with the science, due to hidden agendas and varied responses by popular media***".

The stronger students (>65% individual grade), however, made clear links between science and policy, citing the relationships between emissions reductions and thresholds of GMST.

2. Advancing Students Along the Affective Hierarchy

Confidence and Motivation

Online collaboration exerted a moderate positive influence on confidence (Figure 8.3), and this was also noted in the open questionnaire responses:

"***I would say that my confidence had improved as the complexities and uncertainties were highlighted throughout the discussion (hence there being a lot of material to debate).***"

"***My knowledge improved reciprocally with my confidence. I found myself hunting down elusive references as bland texts came alive and I imagined the consequences of abrupt climatic change.***"

"***When people talk about Global Warming / climate change I now feel more qualified to back up my part in the discussions with scientific facts learned on this module.***"

There were additional benefits for students who were usually inhibited by in-class discussions, and who felt more comfortable in an online setting. This concurs with observations by Dreyfus (2001) and Dengler (2008). Confidence in the online environment and with the material improved over time:

"***I was not very confident that my understanding of the Younger Dryas would enable me to complete the blog at a high level, although this changed after the research which gave me a firm understanding of the climatic era.***"

"***I feel that my confidence has definitely improved using this technique. My understanding was poor at the beginning of this coursework but I now feel that I have a good understanding.***"

It was noticeable that some students, who are normally reserved in class, contributed readily and effectively to the discussion board. However, online exposure challenged some students academically and personally even though they were posting to a friendship group. Supportive and constructive tutor feedback, both written and spoken, was especially important, highlighting the need to be sensitive and flexible to different learner preferences (Anderson *et al.*, 2001). These anxieties also challenge Dreyfus's (2001) suggestion that the online learning environment is risk-free because "*There is no class before which the student can shine and also risk making a fool of himself*" (Dreyfus, 2001, p. 39). It also concurs with previous authors' observations (e.g. Land, 2004) of a strong emotional involvement in online learning and a perception of risk. Rather than risking ideas within the privacy of student-to-tutor communication, students were forced to post material that could be scrutinised by other group members. Some students felt uncomfortable with this visibility, even within a friendship group.

Intrinsic motivation was evident across the module cohort; 88% of the students had chosen the module because they were interested in the topic, with 17% choosing it because it complemented their other modules and 17% believing it would be relevant to their career. The group discussion boards had a strong (52.9%) or moderately (23.5%) positive influence on their motivation to sustain effort and engagement with the coursework and a strong (35.3%) or moderately (41.2%) positive impact on their motivation to engage with academic material (Figure 8.3):

"***The discussion board lasted 4 weeks, 4 weeks which realistically I wouldn't have done as much reading. I read very widely around the subject to try and get a valid point to put in. I wouldn't say spending more time on it is a bad thing. This was my favourite coursework... if there is such a thing?***"

Values and Attitudes

Confidence helps students to achieve within the receiving and responding areas of the affective domain, whereas values and attitudes contribute to the higher-order organisational aspects. There was some evidence of students becoming more willing to accept the complexities inherent in climate change, altering their attitudes to the issue:

"***The sterile facade of the science gave way to a colourful, meaningful and complex system of which we know so little about. I never felt like that about climate change before.***"

"***After researching for this coursework I am much more open minded and aware of other future scenarios which would be unexpected to the majority of people who are not educated in climate change.***"

3. Advancing Students Along the Inter-Personal Hierarchy

Group dynamics

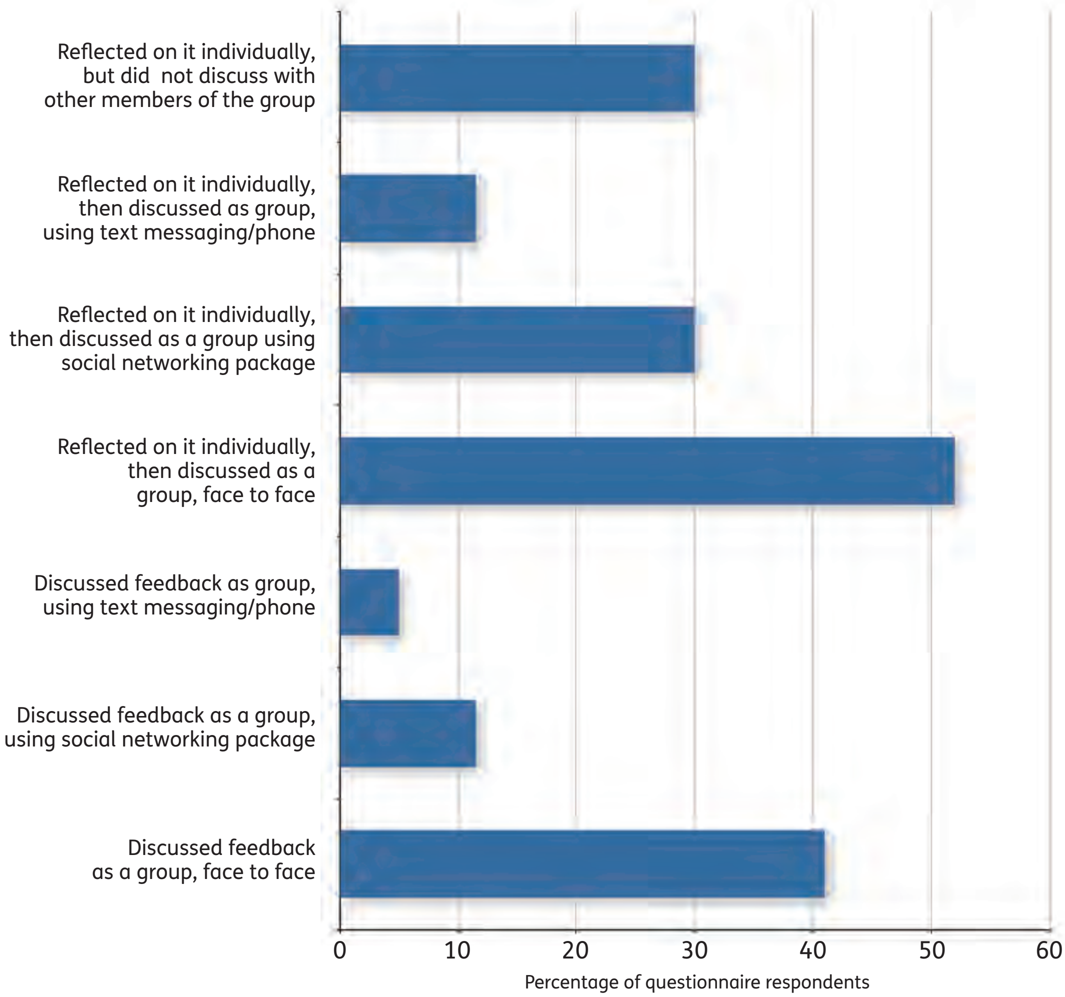
The journey along the inter-personal hierarchy is described here using postings from one of the discussion groups. The first discussion thread, which asked for a summary of the climate characteristics of the Younger Dryas stadial (part a of the coursework brief - Figure 8.1), was descriptive and matched the first stage of sharing/comparing information from Gunawardena *et al.*'s (1998) five-phase model for the social construction of knowledge in online discussion. This simplicity was intentional but, nevertheless, no student went beyond description or challenged another's posting. The second discussion thread (part b of the coursework brief) showed Gunawardena *et al*.'s (1998) second stage of discovery and exploration of dissonance or inconsistency among ideas, concepts or statements (Table 8.4). In such a short exercise it is perhaps unrealistic to expect evidence from the later stages of Gunawardena *et al*.'s (1998) model (negotiation of meaning/co-construction of knowledge; testing and modification of proposed synthesis of co-construction; agreement statement(s)/applications of newly constructed meaning).

Table 8.4 As the discussion boards developed, students began to tackle the dissonance of ideas, thereby moving along the interpersonal hierarchy of Gunawardena *et al*. (1998), as shown by this exchange between two group members.

"As noted by x in the former blog post, abrupt climate change can be caused by small changes elsewhere in accumulated effect" (Alley, 2003). This statement is supported by a study, which found evidence for a cooling event synchronous with the Younger Dryas period in the North Pacific Ocean. It is thought these changes may be related to a temporary shut-down of North Atlantic Deep Water formation, relating to the Thermohaline Circulation shift."
Student A October 26th 2009

"A question we should also be asking is how the THC was interrupted so abruptly. Further triggers and feedbacks must have been responsible for the change, which released melt water into the North Atlantic. To find the answer it is necessary to look to the warmer period directly before the onset of the YD, the Bolling-Allerod (BOA)."
Student B October 28th 2009

Figure 8.6 "How did you as a group respond to the tutor feedback on the discussion boards?"



In terms of building learning relationships amongst the groups, one student found the assessment for the module difficult, saying "*I have never…spoken to other people on my course academically in that way*". Figure 8.6 shows evidence for social interaction during the 4-week discussion board exercise, but also for isolation. Although 53% of the students reflected on tutor feedback, then discussed it with the remaining group members face-to-face, 29% were still working in a substantial degree of isolation, reflecting on feedback individually, but not discussing it with their group. For those who discussed the feedback with their group, there was some effort to choreograph the postings to gain a logical flow of material (Skinner, 2004):

"*I scripted in Word what I was going to say, and ensured that I made comment on other people's previous posts as well as introducing new material, but as a group we never scripted the direction of the forum.*"

The students noted that their ability to make spontaneous, but considered responses to postings was weak, and that they would prefer to practice this type of exercise at Levels 4 and 5. Encouragingly, most of the cohort reflected on tutor feedback before discussing it with their group, and this was evident in the improved quality of postings as the exercise progressed.

As noted by Livingstone and Lynch (2002), well-structured and managed group work can provide students with a set of transferable skills and a vehicle for critically assessing subject matter. The difficulties that have been posited for group work generally (see Healey *et al*., 1996), such as unequal contributions from group members, extra demands on student time, and perceived unfair group composition, are evidenced in the online setting:

"*Not all persons in the group made an effort each week to add to the board, affecting the rest of the group.*"

"*It was very dependent upon who was in your group. I was lucky but feel that for a 3rd year module maybe our grades should not be influenced by other people's efforts.*"

"*The forum comments were difficult to write compared to an individual essay because I had to take care over constant input from group members.*"

However, these difficulties are necessities of the complexity of the team learning experience, which thus strengthens the preparedness of students for the complex environments into which they move after completing their degrees (Livingstone and Lynch, 2002).

Overall, the student responses indicated that they valued the online collaborative discussion boards:

"*A different style, but perhaps more relevant to today, a new skill to learn and a nice change from a straight 3,000 word essay!*"

"*I was pleased that we were being assessed in a serious manner which gave credence to the way in which online discussions appear in the 'real world'*".

Conclusions and Action Points for Change

Overall, students engaged well with the online discussion boards. With respect to the cognitive domain many students were moved along the hierarchy through their individual and collaborative reflection on troublesome and contested knowledge, and the application of climate science to policy. In relation to the affective domains students gained in confidence and motivation with respect to their subject knowledge and ICT skills. For some students, attitudes to scientific evidence and discourse changed to become more accepting of the complexities and uncertainties of climate change. In terms of inter-personal relations there was evidence that students progressed from passive recipients of information to more active contributors and negotiators. Although there were some genuine problems regarding group dynamics, these were relatively easily overcome; the student comments are more indicative of the challenges posed by deeper learning, which require sustained effort and commitment.

These are positive results, but online discussion boards must be managed in a number of ways to optimise student and staff achievement. These are:

- describe the rationale for the project
- clarify expectations for the online environment
- ask clear and engaging, but nevertheless challenging, questions that promote critical thinking, reflection and negotiation
- mediate the work to create an enabling environment for learning
- allow adequate time for student reflection and discussion
- allow sufficient time to develop, deliver and manage new ICT materials
- integrate the technology into the learning environment, supporting and enhancing existing structures and practices with the aim of offering a structured autonomy to students

Within undergraduate degree programmes, a consideration for the future is to introduce online discussion boards to first and second year cohorts. Students may gain confidence in handling complex knowledge and have time to apply this later in their programme. Online discussion boards are a valuable support for face-to-face learning; they are useful for establishing learner groups and for facilitating higher-order academic skills development early in the learning journey.

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