

A fire to be lighted: a case-study in enquiry-based learning

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Abstract

This article considers a new MSc course which was designed to have enquiry-based learning at its centre. The elements of the course are discussed and the whole taken as a case-study in the promises and challenges of enquiry-based learning, with a particular view to the extension of enquiry-based learning practice to undergraduate and larger enrolment programmes. The key innovation of the module is to structure the teaching and learning activities according to clear questions which articulate debates within the discipline. These questions constructively align the aims, activities and assessment of the course, providing a transparency which allows students ownership of their learning process. It is concluded that enquiry-based learning both speaks directly to the core values of the University and contains the potential to reinvigorate teaching without carrying prohibitive costs in terms of resources.

Keywords: Enquiry-based learning, MSc, psychology, case-study, CILASS

Introduction

This is the story of PSY6311, 'Debates in Cognitive Neuroscience', a new MSc module which tried to put enquiry-based learning at its centre. This article will outline the structure of the module, and the accompanying motivations for each element of the module design. It will conclude with a discussion of what worked and what didn't, along

with my attempts to discern why. The first time the module ran it had about a dozen students, all of whom had already taken an earlier module 'Fundamentals of Cognitive Neuroscience'. Although the students (like myself) had some experience of enquiry-based learning, it was a novel experience for most of them (like myself) to participate in a module which cast itself as fundamentally concerned with enquiry-based learning.

The immediate context for the creation of this new module was the launch of two new MSc courses in the Department of Psychology at the University of Sheffield. Both MSc courses had similar content (they have since merged) and were aimed at preparing students from diverse academic backgrounds for a research career. The students who enrolled had first degrees in subjects as diverse as biochemistry and electrical engineering as well as the psychology and neuroscience backgrounds you might expect.

My ambition for the module was to move away from the pure lecture and exam focussed instruction that characterises many University courses. Instead I wished to use the module structure to catalyse student-led enquiry into the topics to be considered.

The motivation for this was an interlocking set of assumptions about what are, and are not, desirable characteristics of a University-level education. A widespread implicit model of education is of students as receptacles, who receive a substance (education) from teachers, who then judge the students' success according to how fully they can regurgitate the material with which they have become 'filled'. This is Freire's (1972) 'Banking' model of education (for a brief, but damning, exposition see Edwards, 1995, pp116-118). Freire (1972) writes forcefully about the dichotomies that this model of education assumes, and thus reifies, across the teacher-student divide: activity – passivity; knowledge – ignorance; choice – compliance; teaching – learning. This receptacle model of education discourages creativity in the place of credulity, he argues. There is an alliance between student passivity (and oppression), according to Freire, and the assumption that the content of what education is 'about' is prefigured, a canon of knowledge.

An alternative broad model of education is of it as a transformative process, based around the active-agency of the student. Freire (1972) proposed 'problem-posing' education. More recently a good deal of interest has arisen around the topic of 'enquiry

based learning' (Brew, 2001; Hutchings, 2006; Kahn and O'Rourke, 2005). In enquiry based learning (EBL) the focus is on praxis as much as content. Students are presented with open-ended scenarios or tasks which allow different solutions or approaches to be developed. Enquiry-based learning has been criticised (see, for example, Kirschner, Sweller & Clark, 2006) and it is not clear that it is appropriate for all levels of education. Certain stages or subjects of education do require a prioritisation of instruction of basic facts over guided-exploration. Nonetheless, EBL has been found to be effective in tertiary education (Prosser and Trigwell, 1999). Not only does EBL offer the promise of more closely allying research and teaching (Jenkins and Healey, 2005), there is an obvious correspondence between the mode and ethics of EBL and the aim of preparing students for a research life which consists largely of being an independent learner.

My feeling when designing the new module was that the banking model of education had been over-favoured, both in my own teaching and generally. It was appropriate to start to address the balance by applying a transformative model based around the active agency of the students, in line with EBL practice. Although scientific psychology aims to produce certainty, a canon of knowledge in effect, this module would de-emphasise certainty and instead highlight the skills, ethics and habits of thought needed to deal with the uncertainty of psychological research.

The pedagogic concerns that motivate EBL are not novel, but universal. As Plutarch (c. 46 – 120 AD) wrote

*The mind is not a vessel to be filled,
but a fire to be lighted*

The concern of this article is to convey practical steps which were taken in designing PSY6311 so that it maximised the enquiry-based elements of the module while maintaining those elements required by a conventional university course (i.e. assessment etc).

Course Structure

With this context for the creation of the module in mind, I turn to the formal structure of the course. The key to the structure of the course is that each topic-block was based around a question. These questions introduced the topic for each block, and focussed the process of enquiry.

The four questions were:

- What causes dyslexia?
- Does the brain use common systems to support both language and music?
- How is dopamine involved in reinforcement learning?
- Assess the strengths and weaknesses of one, or more, research methods in one, or more, areas of cognitive neuroscience.

These questions were chosen because they are the kinds of questions which we might hope research in the department could help to answer. They are genuine open questions, although theories exist as to the answers, these are contested. The questions allow a re-focussing on the mutual ignorance of staff and students, rather than on the normal asymmetry of staff knowledge and student ignorance.

The four topics were covered consecutively across the module (see table 1 for the module timetable, the module introduction and outline which was given to students in provided in appendix 1). The structure for each block was similar, although there were some variations due to timetabling constraints. There was a 50:50 mix of staff-led and student-led sessions. The first staff-led session, usually, the first session of the block, was an introductory lecture, given by a member of staff who was active in the research area. We were lucky enough to be able to recruit a number of professorial staff to teach on this module, who were able to give an expert introduction to the necessary background and context for each topic question, as well as to recommend some initial readings on the topic. The next staff-led session would be a seminar by the same member of staff, which was based around answering student's question from the introductory lecture and those which arose from their reading of journal articles. Submitting these questions was a part of the course assessment, and took place via an internet bulletin board (the rationale for this is discussed below). This second staff-led

session sometimes took the form of a mini-lecture with an extensive question-and-answer component, and was sometimes a guided discussion led by the member of staff.

The student-led sessions were left open to be run however the students wished, but in practice they were round-table discussions in which information was presented and aspects of the topic-questions debated. The aim of these student-led sessions, and the “to be arranged” sessions at the end of the module timetable, was to provide time for whatever activities the students thought would be most useful for self-tutoring themselves to answer the topic questions. A second component of assessment was a peer-review by the students of each others contributions to these student-led sessions. Finally, at students’ request, a couple of sessions were added to the timetable devoted to the discussion of how the assessed essays should be structured, and for feedback on individual's provisional essay plans.

Table 1: Module timetable. Each session is 2 hours long. Sessions without allocated staff are student-led

Session No.	Date	Topic	Staff
1	11-Feb	Intro	TS lecture
2	15-Feb	Dyslexia	RIN lecture
3	18-Feb	Dyslexia	
4	22-Feb	Dyslexia	RIN seminar
5	25-Feb	Dyslexia	
6	29-Feb	Plans	TS workshop
7	03-Mar	Music & Lang	
8	07-Mar	Music & Lang	LP lecture
9	10-Mar	Music & Lang	LP seminar
10	14-Mar	Music & Lang	
11	07-Apr	Dopamine	PR lecture
12	11-Apr	Dopamine	PR seminar
13	14-Apr	Dopamine	
14	18-Apr	Dopamine	
15	21-Apr	Methods	TS lecture
16	25-Apr	Methods	
17	28-Apr	Methods	RV lecture
18	02-May	Methods	OP lecture

19	05-May	Methods	
20	08-May	Plans	TS workshop
21	12-May	TBA	
22	16-May	TBA	
23	19-May	TBA	
24	23-May	TBA	

Assessment

The module assessment had two components. The major component (80% of the final grade) was based on written coursework consisting of two 1500 words answers to a free choice of two out of the four topic questions. The minor component (20% of the final grade) was based on ongoing participation in the activities of the module. A number of authors have questioned the appropriateness of traditional assessment formats such as exams and individual coursework essays within an EBL context (e.g. Macdonald and Savin-Baden, 2004) so the adoption of the assessment by essays on this module perhaps bears some explaining. The rationale was that academia remains primarily a literate culture, where a good deal of professional activity is aimed towards expression of ideas in written form.

Given the status of the MSc as geared towards preparing students to become part of the academic profession, it is appropriate that the assessment should reflect the primary activity and values of academia, namely written argument. Steps were taken to remove two perceived pitfalls with assessment by written answers. Firstly, because the questions were known in advance, it is possible for the students to avoid question spotting, and can instead focus their participation in the course activities. They were explicitly told that their task during the module was to tutor themselves to reach the position where they could confidently answer the questions. Secondly, a marking proforma was created for use by the members of staff who would mark the coursework, the same professors who taught on the course, so that they were encouraged to mark according to a common set of criteria based around the clarity of the writing and the strength of argument, rather than around the match of the contents of the essay to any preconceived ideas of what a 'correct' answer should look like (see Appendix 2 for this). The proforma was also distributed to the students and it was emphasised that the best essays would make a strong argument about a specific points, rather than cover all

aspects of the topic superficially.

The activity based component of the assessment accounted for 20% of the final mark. It was divided between marks for asking questions after each of the four introductory lecturers, and marks based on a peer review of contributions during the seminars. Note that it was strictly possible to pass the module without participating in the ongoing activities at all. This was intended. The motivation for the on-going activity assessments was not to discriminate between the students (c.f. the essay-based assessment) but to create a structure by which all students would be given some extra motivation to take part in the module-process, which in turn had as its objective the completion of the essay questions. Asking questions after each of the four introductory lectures was weighted at one-third of the total 20% for activity-based marks available.

The quality of the questions was not judged, beyond the basic criteria of relevance. This was to emphasise the importance of the habit of question asking, and de-emphasise concerns about the quality of questions (concerns which are often attended by a belief that asking questions is an ability based on superior-knowledge and which you either necessarily have or have not, rather than being a skill which you gain by practice). So providing 'easy' marks to the students for asking questions encouraged them to do just this, fostering their question-formulating skills while also providing the individual and group benefit of having questions raised. Questions were submitted after the introductory lecture on the topic, via an internet discussion board. The purpose of this was to make the questions asked 'public', so that all the group could see what questions had already been asked (just as an audience at a lecture can hear what else has been asked at the end of a lecture). As well as emphasising the social norm of asking questions, this allowed all students to benefit from hearing each others questions, and created a space for both staff and students to join in answering and discussing the different questions raised.

The other two-thirds of the activity-based marks were awarded according to a peer-review of participation in each of the four blocks. Again the discrimination between levels of participation, like discrimination between quality of questions, was minimal. The students were encouraged to award each other the maximum marks for any participation which was not actively harmful, rather than to try to judge what counted as

'excellent' participation in the groups' activities in any way.

Both these components of the activity-based assessment served the purpose of making explicit my expectations as module organiser for how the students should behave. Psychological research has shown the enormous power of both social norms (see Cialdini, 2007, for a brief recent review) and of habits (Ajzen, 2002; Ouellette and Wood, 1998) in guiding behaviour. One way of changing behaviour is by 'reframing' what is considered the default option, in other words, by contriving a normally opt-in behaviour to be an opt-out behaviour (Johnson & Goldstein, 2003); for example Choi, Laibson, Madrian & Metrick (2004) demonstrated that whether a company pension scheme was opt-in or opt-out dramatically affected pension saving rates among employees. Note that the argument here is not that employees' preferences were changes rather that their behaviours were determined by the circumstances presented to them --- and thus, presumably, the companies that offered pension saving as a default (opt-out) succeeded in allowing many employees, who otherwise wouldn't have saved, to match their preferences with their behaviour.

To return to the classroom --- unfortunately *not* asking questions and otherwise *not* contributing to discussions can become the default behaviour among students, a social norm reinforced by habit. This is especially a risk in teaching environments dominated by passive instruction rather than active inquiry.

Making asking a question, any question, part of the course assessment establishes a new default behaviour, which, it is hoped, will in time become reinforced by habit and social norms. As well as enhancing the group dynamic it is also hoped that individuals will come to learn that participating is not aversive, indeed can even be rewarding (one factor which maintains negative evaluations is that such evaluations motivate avoidance, which prevent disconfirmation of the evaluation; Eiser, Fazio, Stafford & Prescott, 2003. Or, put simply, if I think that I won't like something I never try it, and thus never find out that if I would have enjoyed it).

Although these 'participation' elements of the assessment provided 'easy marks', in some sense, this was balanced by the high standard of prose and argumentation expected in the (majority) essay assessment.

Successes

The atmosphere of the classes was extremely positive, with staff and nearly all students enjoying a high level of engagement with the material and each other. All staff who took part enjoyed their teaching and most students enjoyed learning in a more enquiry-based atmosphere (several even describing the module as the best they'd ever done).

Seven out of eleven of the students achieved distinction-level grades on this module, and none failed. This is suggestive of high-engagement, but it is obviously still unclear if the higher pedagogic aims of the module were met; did the students leave better prepared for academic careers? What criterion should be used to assess a module which has as its aim to foster independent enquiry, an activity which has at its heart the self-determination of its own criteria of value and success? Individual modules are rarely assessed for their overall contribution to student development. One exception, which compares EBL and conventional teaching, is Oliver-Hoyo and Beichner (2004). It is clear that the evaluation of the module is both problematic and one which requires attention. The module must be critically evaluated, and I hope some of evaluation is evident in this current paper, but I am not clear yet as to what more formal structure for critical evaluation should be introduced. One possibility would be, like Oliver-Hoyo and Beichner (2004), to take pre and post-module measures of attitude to, and confidence about, EBL-style activities such as group work and presentations. For the present purposes we must be content with the subjective assessment of the participants, both staff and students, who enthusiastically rated the module a success. Below is a list of elements which were key in the successes of the module, such as they were.

Questions

This idea of 'teaching questions rather than answers' was key to the course (for an earlier review of this, see Stafford, 2008). This allowed the 'constructive alignment' (Biggs, 1996, 1999) of the course aims (see appendix 2), activities and assessment. 'Constructive', in the sense that it acknowledges that during the learning process students have to construct their own understanding of the material; 'Aligned' because the course activities and assessment both serve the learning outcomes of the course. By hanging the course activities and assessment off the 'hook' of these questions it was

possible to make the motivation for all these activities transparent. The goal at each moment in time is explicit, simple and shared between the staff and students: to discover and articulate answers to the topic question. The learning outcomes of the module were to foster those skills needed by a researcher in the field; to apprehend an ambiguous and contradictory literature, to perceive areas of certainty or of potential progress and to articulate a considered position on the topic. Picking questions which encapsulated controversy in areas of contemporary research made it easy to match course activities to these learning outcomes.

The use of questions disrupts the authority of the lecturer by focussing on areas of common ignorance. By making explicit the purpose of the classes it shifts the power-balance of the classroom in a very practical way. If students know, in concrete terms, the purpose of the class then they can develop the capacity to assess how useful the lecturer is being in furthering that purpose. Compare a lecture with the vague aim "To know about X and Y" versus the more specific aim "To know why X causes Y" (for example). Sitting in the first you have to trust that the lecturer is providing the required knowledge. By definition you are in the lecture because you are *ignorant* of X and hence unable to make judgements about it until *after* the lecture --- by which time, of course, it is too late to ask how well you are being taught and affect it. If the aim to answer a specific question then you are more empowered to question the methods of the lecturer, in effect to ask "How is this helping me understand the answer to why X causes Y?". Furthermore if you don't understand how an element of the lecture plays a part in explaining why X causes Y then the aim of finding out the answer to the question actively enjoins you to stop the lecturer and request that she makes it clear. You can only do this because you know what it is you are being asked to understand in advance of understanding it.

So the use of questions to structure the module allows the students to 'own' the teaching time that they must endure, encouraging them to view the lecturers as a resource rather than simply a source of knowledge. This is, of course, in fitting with a focus on transformative inquiry rather than passive knowledge-acquisition

Physical space

The arrangement of physical space to match the desired activity of the class was important (Hutchings and O'Rourke 2006a; Oliver-Hoyo and Breichner, 2004). It is hard to have a seminar in a lecture room with all the chairs facing one way, just as it is more difficult to have a lecture when there is no central focus in the arrangement of seating. Perhaps most importantly the choice and/or arrangement of room is taken by a class as a powerful indicator of how you really want the session to run. The majority of the sessions on the module ran excellently, with a lively engagement of staff and students. It was noticeable, however, that the choice of rooms strongly affected the dynamic (we used four different rooms at various points during the course), even with the same staff and students present.

Marking Proforma

The use and distribution of a marking proforma was in keeping with the 'transparent' way the module was run. It allowed the students to see explicitly how they would be assessed, and also warned the staff from marking according to content, rather than argumentation. The use of the proforma for the staff was a recognition of the risk that students who disagreed with the lecturer might be discriminated against, and that lecturers' habits, such as marking on content, might interfere with their assessing in line with the spirit of enquiry-based learning just as students habits might interfere with their working in line with this spirit.

Challenges

Not all elements of the module worked as intended. What follows is a discussion of what didn't work and/or what negatively impacted on the module.

Like others have found (Corsín Jiménez, 2007, Pond, 2004), some students didn't like the lack of clear structure in the course. The majority of the sessions for the module were left 'unplanned', since I had intended students to fill these with 'whatever they wanted'. This freedom was not entirely welcome. Related to this was, I think, my naive belief that I could step back from the running of individual sessions while physically present. It was my initial ambition to allow the students to chair individual sessions as

they saw fit, mirroring the freedom they had to decide of the content of the sessions. It became clear early on that this wasn't happening and wouldn't happen and my intervention was required to get things going. I realised that, like the physical arrangement of the room, my simple presence was taken as a strong signal to the way the class should run. I could not divest myself of the authority of a lecturer by simply saying "You run the session" and stepping back. My continued presence contradicted my explicit statement here.

The way out of this bind, I believe, is to use teacher authority, just like the physical arrangement of the classroom, to create structures which catalyse student self-responsibility. In concrete terms, what I am doing now when teaching the module is, at the beginning of term, assigning each session to be chaired by a named individual student. In this way my authority will be employed to insist that students take on a chairing role, rather than adopting the contradictory position of asking that this happen without taking any specific steps to make it. Although it could be argued that this dictatorial act mitigates against student autonomy, I view it rather as a necessary first step in a group where, typically, none of the students will have chaired a session.

I have discussed above the power of social norms. A caveat to this is my belief that many of the problems we face as teachers are as much problems of social-comfort, rather than necessarily intellectual problems or teacher-centred problems. Many students won't speak in class if they feel uncomfortable with the teacher or the other members of the class, irrespective of their level of confidence with the material being taught. The flip-side of this fact is that we, as teachers, can use social groups to create mutual obligation. The peer-review of participation was an attempt to encourage this, but perhaps far more successful (although not explicitly envisioned) was the division of the reading among members of the group so that subsequent sessions could involve everyone reporting back. In higher education, and especially on a masters level course, we are lucky enough to have students who certainly want to engage. Formal structures, such as the peer review of participation, and informal structures, such as the social obligation of bringing a paper summary to the discussion, can unlock this desire and help it manifest in behaviour (which is in turn self-reinforcing).

It is critical to ask if it will be possible to scale-up modules like these to larger cohorts. Some have found that teaching enquiry-based modules has been more staff-time

intensive than conventional teaching (Corsín Jiménez, 2007). I do not believe this has to be the case. Indeed, if enquiry-based learning was synonymous with a greater staff hours-to-student ratio then it would be nothing more than a plea for more resources in education. This would make enquiry-based learning less of a pedagogy and more of a demand for structural change at the social/institutional level. Instead, I believe that enquiry-based learning does offer insights into how to provide quality learning experience within normal institutional constraints, especially at university level.

The key to this is that encouraging student autonomy, which must be at the heart of enquiry-based learning, can both increase the quality of the student experience while reducing demands on staff time (Oliver-Hoyo and Breichner, 2004). Some tasks, such as seminar chairing, can be made the responsibility of students and thus provide experience of an important professional skill for them whilst freeing staff time up for concentrating on other elements of the course. I suggest that a similar exchange can be made with many lectures, if these are devoted to conveying information which is available in a textbook then perhaps they can be cut and substituted for a structure which explicitly puts the responsibility for apprehending the information on to the students.

The lectures on this module were closely integrated with the structured student activities. It was possible to recruit professorial staff to teach precisely because the structure of the module only required a couple of hours from each member of staff, and these hours did not require much preparation. The first lecture was based around the member of staff's active research interest, as such it was easy (even enjoyable) for them to give a lecture on. The second session with them was based around student questions, so again did not require much in the way of preparation. This meant that all the time of the staff was spent in active engagement with the students, half of it responding to student questions.

Sometimes it is difficult for us, as teachers, to be 'irresponsible' enough to allow students autonomy in their activities. We do not feel that we have 'taught' a topic unless we've covered it fully in lectures (Oliver-Hoyo and Breichner, 2004), or that we can risk having a seminar chaired badly, so we should chair it ourselves. However, I believe that with the right structure made explicit, it is not just possible but desirable to make

students more responsible for their learning. More student autonomy means more risk of error, but that itself is not a bad thing (indeed mistakes are a vital part of the learning process). What a scaled-up enquiry-based course requires is that staff-time freed up due to greater student responsibility is dedicated to appropriate monitoring of student participation, satisfaction and education so as to catch and head-off individual and group failures. If this module were to be scaled-up to larger cohorts I would introduce explicit self-assessment benchmarks which students could use during the course to gauge their progress. Another potential innovation would be to timetable a session for peer-review of essay plans. Again, this could seem irresponsible, given that the 'best' feedback on essay plans might be presumed to come from the module-organiser.

However by asking students to review each others' plans we would create the opportunity for them to develop their internal model of what an essay should be like, to develop the perspective of a reader, rather than just a writer of essays. It would also motivate the students to engage with the essay marking criteria in a way that they might not if merely told what they are (as currently is the case). So, rather than staff-time being spent providing feedback on essay plans, it would be invested in designing guidelines to help students learn to give feedback on each others', and their own, essay plans (the issues surrounding peer assessment are reviewed in Dochy, Segers & Sluijsmans, 1999, Falchikov and Goldfinch, 2000, Topping, 1998). It would also, obviously, be necessary to monitor the process, and, if required, provided some specific feedback in individual cases, or generic group feedback after the 'first-pass' peer review.

Two things that surprised me about the students who took this module were, firstly, the lack of confidence in the students, despite an obvious enthusiasm and high level of intellectual ability, and, secondly, a lower level of literate ability than I anticipated. It may be that the introduction of an enquiry-based learning module at MSc level is too late to avoid the inculcation in the students of a contrary culture, namely one based on the passive reception and memorisation of information.

It is this same culture which obviates against the development of articulate argumentation in written work. Alan Dewar (A. Dewar, personal communication, 15 July 2007) writes,

The essential distinction is made by Bereiter and Scardamalia (1987) between knowledge-telling and knowledge-transforming composition. Using writing to think is actively militated against in schools, in my view. The governmental drive to assessment is profoundly affecting the use of writing in schools, and the National Literacy Strategy is exacerbating the analytic/prescriptive model of composition which (I claim) can only lead to knowledge-telling... One of the roles of the teacher in tertiary education must be to show students how to participate in the discourse of the subject. How does a psychologist/engineer think? How does a psychologist/engineer write? Students need to see the writing/thinking process. How do they know that experts use writing to think unless they see it happen?

This line of argument clearly touches on wider issues. Suffice here to say that although the aims of the module were to develop skills of written argumentation, and although these were part of the assessment criteria, it was naive of me to think that merely enjoining students to produce clear prose with a strong argument would be sufficient to help them to do this! Fortunately the module timetable was flexible enough to allow the introduction of some remedial classes based around the skills of essay planning to address this. The larger issue remains of whether a single module can achieve much if writing skills, like confidence, are actively mediated against by much of preceding education. I say actively mediated against because I do not believe that these skills are just not taught, I believe that the manner of teaching works against their development. As Johnstone says (1979, p.16)

People think of good and bad teachers as engaged in the same activity, as if education was a substance, and that bad teachers supply a little of the substance, and good teachers supply a lot. This makes it difficult to understand that education can be a destructive process, and that bad teachers are wrecking talent, and that good and bad teachers are engaged in opposite activities.

Freire's 'banking' model gives us a framework to understand why this is the case. By focussing on the transmission of a canon of knowledge we also drill into students the receptacle model of education, and their own inferiority in face of it (and the authority of the teacher). How can we then expect students to have the confidence to ask questions? By judging student's worth according to formulaic answers to exams, which we then mark by the hundreds, we encourage them to focus on the content of what they include in their answers, rather than on the detailed articulation of an individual line of thought. How can we then expect them to leap, fully-formed, into this style of writing at an arbitrary point in their education?

Tradition and Enquiry Based Learning

Enquiry is at the heart of the university ethic. We should reflect this in our teaching --- not just in what we say we want students to do, but in what we expect and encourage students to do, and in what we reward them for. To quote Hanauer (2006, p1880),

The goals of scientific research and current pedagogical practice are at odds. In our culture, schools are designed to present established understandings, not to promote discovery of new knowledge. The focus on persuading students of the correctness of stated information is intensified by increased reliance on broad-based standardized testing, which—especially in the United States and the United Kingdom—has become a popular mechanism for making schools accountable. The ensuing culture of conformity with established knowledge is the very antithesis of scientific inquiry.

Most staff and students who took part in the module described in this article were enthusiastic about the potential for more enquiry based learning (although they may not have used this phrase). All that was required to tap with enthusiasm was to create structures where this appeared a feasible possibility. In terms of physical and staff resources the module did not make any exceptional demands. My hope is that the practical principles of enquiry-based learning, which can be discovered through experiments such as this module, can be developed and spread out to larger undergraduate programmes. The culture of pedagogy that is growing up around enquiry-based learning has great potential to reinvigorate university teaching.

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APPENDIX 1 – Module description and coursework assessment proforma

Debates in Cognitive Neuroscience

This module is designed to enable students to explore areas of active contention in cognitive neuroscience. For example: What causes dyslexia? Do music and language utilise common systems? Where does the brain calculate reward? What role do different methodologies have in addressing these topics? The module includes a number of specific topics. Each topic is introduced by an expert in the field, but the bulk of the module is based around collaborative investigation, debate and discussion in seminars. This format provides the opportunity for students to develop a position on some contemporary and unresolved issues in cognitive neuroscience, and encourages development of the core scientific skills of team-work, communication, sceptical inquiry and critical appraisal of research findings.

Aims & Assessment

For the 2006-7 session the questions considered on the module will be:

- "What causes dyslexia?" (RIN)
- "Does the brain use common systems to support both language and music?" (LP)
- "How is dopamine involved in reinforcement learning?" (PR)
- Assess the strengths and weaknesses of one, or more, research methods in one, or more, areas of cognitive neuroscience (TS)

The aim of the module is that each student should become familiar with the debate among cognitive neuroscientists surrounding these questions, and should reach a point where they will be able to articulate their own opinion on what the evidence shows.

Assessment is:

- 80% based on two 1500 word essays answering 2 out of these 4 questions
- 20% based on contribution to group work during the module

Learning Outcomes

This module aims to foster the skills of a working cognitive neuroscientist. In particular those of skeptical appraisal, collaborative discussion and individual articulation of a position, both written and verbal.

After completing this module the successful student will have

- gained a deeper understanding of the cognitive neuroscience topics covered

The module will develop the skills of

- asking questions in an academic environment
- cooperating with others to research, present material on, and discuss topics
- putting individual research findings in context
- writing in a clear academic prose style
- writing well structured arguments with all factual claims supported by evidence
- making an interesting, convincing, case in writing

The Coursework Essays

The essays should be no more than 1500 words and will be marked on the standard 100 point scale and contribute 80% of the total mark. The assessment criteria for this written work are based on the generic University criteria for masters students (see <http://www.shef.ac.uk/content/1/c6/05/27/87/Generic%20criteria.pdf>), which are in turn are inspired by the highest standards of academic writing

Specifically, we are expecting that written answers will demonstrate:

- an ability to critically evaluate the different positions taken on the topic
- a comprehensive understanding of the context of recent research findings and contemporary methods
- an ability to deal with complex issues systematically and creatively;
- independent thought.

More concretely it will be expected that all students will write answers in good, clear, english. Answers will directly and concisely address the question. Answers will follow a clear line of argument, making obvious why all material discussed is being included.

Due to the nature of the questions considered in this module there will be no standard or correct answers, but instead the quality of the analysis, review and articulation will be apparent in any well reasoned and supported answer. Independent and original lines of argument will get the highest marks, provided the evidential motivation for such arguments is made clear. It is not expected that answers will cover all of the material taught on a topic; better answers will omit some relevant material in order to make a tighter, clearer, argument. Students should not: discuss material relevant to the question without contextualising it within the frame of well structured argument; use technical language loosely, incorrectly or ambiguously; make generalisations or unsupported factual claims; rely on cliché, received wisdom or the opinion of the lecturers on the module. Essays will be marked anonymously and independently second-marked. A proforma (at the end of this document) will be used during marking.

Group Work

Contribution to group work in each of the four blocks will be marked out of 24 and will contribute 20% of the total mark

1. Question submission

After the first lecture in each of the four blocks each student will submit a question to be addressed in the second lecture.

Questions will be marked according to the following scheme

No relevant or comprehensible question submitted: 0

Any question, no matter how profound or trivial: 2

After all questions have been submitted they will be available for the rest of the module for other students to view

2. Peer review of contribution to group work

After the second lecture there will be an opportunity for students to divide into groups to research the different positions taken on the question-topic.

The third session will be a seminar in which the students will present their research, and discuss what further information they would like to recruit to consider this topic.

The fourth session will have content determined by the students and will involve presentations by individual students on a paper they have read, summarising the evidence presented and contextualising it within the wider debate

Assessment will be determined by peer ranking of contribution in each block. Each student will assess the contribution of every other student according to the following scheme

No contribution whatsoever, or detrimental contribution: 0

Minimal & reluctant contribution: 2

All other flavours of contribution: 4

The average of all other student's ratings will determine your grade. Note that the contribution component is worth twice as many marks as the question submission component.

APPENDIX 2 PSY6311 Assessment proforma for staff marking the exam

1. Clear Prose

Is the use of English clear? Is it simple? Unambiguous? Grammatical? Are technical terms used correctly? Is the tone appropriate for an academic essay?

2. Explicit Thesis & Structure

Is the thesis of the essay clearly stated? Is the structure of the essay made clear? Is the motivation for the inclusion of each section made explicit?

3. Grasp of relevant material

Are statements of fact backed up by reference to experiments which support them? Are limitations of findings acknowledged? Are unsupported generalisations avoided?

4. Quality of Argument

Is the argument self-consistent? Are points introduced in a logical order? Does the conclusion follow? Is the argument sufficiently opinionated, interesting, ambitious and/or solid?