Essay

What is the Constructivism in Constructive Alignment?

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Abstract

This paper examines the concept of constructive alignment in respect of science education. The concept is placed in the context of its two contributory components - constructivism and instructional alignment. The former has a well-established body of critical literature that highlights the challenges of constructivism for both science and science education. The instructional alignment component is a long-standing behaviourist approach to curriculum planning. Linking the two components in constructive alignment purports to offer "a theory of learning that is broad-based and empirically sound, and that easily translates into practice" married to "an aligned design for teaching". This approach appears to have the uncritical support of key organisations in UK Higher Education. However, we suggest that linking two contested theories is unlikely to lead to generally sound advice on either curriculum design or approaches to science teaching.

We would identify our perspective not as that of constructivists, but rather as realists, accepting that "science is a construction, but one in which discoveries are irreducible to the construction and social conditions, which made them possible" (Bourdieu, 2004).

Keywords: Constructive alignment, constructivism, phenomenography, expertise, Mode 2 knowledge

Introduction

The use of language in proposing 'new' educational theory lies, we suggest, behind the notion of constructive alignment. This is an approach to enhancing teaching, proposed by Biggs, which claims to "represent a marriage between a constructivist understanding of the nature of learning, and an aligned design for teaching" (Biggs, 1996, 2003). In a much quoted paper on the trajectory of constructivism in science education in UK schools, Solomon notes the way in which new ideas in social science use language in new ways (Solomon, 1994). She comments that "the notion that language plays an important part in the creation of new ideas may be worrying to natural scientists" who use language in precise and unambiguous ways. With this in mind, we discuss constructive alignment in the context of some of the recent debate in science education and highlight some of the issues that are current in Higher Education (HE) about the consequences of constructivism as a pedagogy and/or epistemology (theory of knowledge), for science and science education. Pedagogy is often defined in narrow, technicist, terms as a way of teaching, but this definition misses much of the point of pedagogy. The definition we prefer is "a sustained process whereby somebody(s) acquire new forms or develops existing forms of conduct, knowledge, practice and criteria from somebody(s) or something deemed to be an appropriate provider and evaluator – appropriate either from the point of view of the acquirer or by some other body(s) or both" (Bernstein, 2000).

In the education literature, constructivism is represented variously as a theory of learning, teaching, education, cognition, personal knowledge, scientific knowledge, and a world view - in all a "grand theory" (Matthews, 2002). With such a range of differing/overlapping dimensions, it is scarcely surprising that Scerri (2003a, 2003b) has identified and criticised philosophical confusion in the chemical education literature in respect of constructivism. There is at least as much confusion in the education literature covering other science disciplines.

Constructivism and Science Education

Within science education, a major difficulty with the use of the term constructivism, is a failure to distinguish between constructivism, versus realism, as a theory of knowledge, and constructivism as a theory of learning (Colliver, 2002a). Jenkins (2001) has argued for greater clarity and precision when referring to constructivist ideas in science education (notably in primary education). Solomon noted that mature constructivism abrogates all other avenues of research and that this tunnel vision is apparent in repeated investigations into school teacher misconceptions and ignorance of scientific matters, rather than action on the deficiencies (Solomon, 1994).

There are many examples of the difficulties with constructivist approaches and the central notion that science education is about 'making sense' of the world rather than establishing a valid scientific understanding of natural phenomena. If we adopt constructivist, especially relativist constructivist, views we can hardly complain about the 'sense' that many individuals make of the world. Further, Cobb (2002), as a constructivist educator, has drawn attention to what he designates a 'category error' in applying a theory of learning to advice on teaching.

Given the constructivist viewpoint that knowledge claims are simply justified (i.e. what works), rather than verified (Coll and Taylor, 2001), it has even been debated whether it is possible to have a constructivist epistemology. Harre (2002) has warned of "the danger of supposing that every explanation that works must be the true account of the causes of a phenomenon". Harre uses the field concept, the movement of sap in plants and the imprinting processes in young animals to illustrate the importance of well-designed experiments and the theories underlying them in deciding between competing hypotheses.

In our view, one of the critical aspects of science education is practical work (laboratory or field). Bourdieu reminds us that "Practice is always underestimated and under-analysed and yet understanding it requires much theoretical competence, much more, paradoxically, than understanding a theory. The difficulty of initiation into any scientific practice lies in the fact that a double effort is required to master the knowledge theoretically, but in such a way that this knowledge really passes into practice and does not remain in the state of a meta-discourse about practice" (Bourdieu, 2004). There is no substitute for time spent in practical work and it is valued highly by students (Willmott, 2005; Jervis *et al*, 2005). In spite of this, and not solely because of the decrease in unit of resource or lack of investment in science teaching laboratories, students' hands-on experience of practical work has diminished dramatically in the last two decades. We conspire with 'managerial' requirements to reduce practical work because of other demands on our time (demonstrating *is* time consuming, especially to repeat groups of students; practical work *is* expensive - consumables, lab space, technical staff salaries; health and safety considerations *are* onerous; we *could* be doing other things - our own research for RAE output, quality assurance audit trail generating, attending staff development or management away days; we *could* be writing about teaching and learning instead of doing it). We also subtly conspire with reducing formal contact time for students on the grounds that 'they are here to read for a degree' and need to have part-time jobs to keep their debts under control. Practical work is particularly time-consuming for both students and staff - how much better to have IT-based, flexible alternatives to allow students to acquire the additional generic skill of time management (so much more useful to most graduates than knowing how to pipette, prepare samples for chromatography or collect and interpret data).

Bourdieu has identified the tacit, or openly complicit, strategies adopted by both staff and students to lessen overwhelming workloads (Bourdieu, 1996). However, none of the alternatives to working with students in the laboratory or in the field can substitute for this unique aspect of science education - yet we continue to accept the apparently inevitable decline whilst simultaneously worrying about why students are not choosing science. The constructivist 'what works' view elides with minimising the opportunities for students to carry out experimental work themselves. Together, these factors diminish the ability of students to challenge their own constructs or those of others.

Matthews has written extensively on constructivism in maths and science education (e.g. Matthews, 2002, 2003), identifying it as a "broad church doctrine", not simply non-behaviourist learning theory as it is often pragmatically represented, and locates it as part of the more general "science wars" (Gross *et al*, 1996). We leave readers to study the arguments about constructivism as philosophical, social and psychological theory in the literature quoted in this paper, (which is of necessity, a small and subjectively informed introduction to a very contested field) and elsewhere, and make up their own minds as to their position in the debate. However, we suggest that reading the robust defence of science in "The Flight from Science and Reason" (Gross *et al*, 1996) and the arguments against evolutionary psychology in "Alas Poor Darwin" (Rose and Rose, 2001) will provide a good counterpoint to the voluminous literature on constructivism.

The return of constructivism

Although Solomon's 1994 paper was titled 'the rise and fall of constructivism', constructivist theories influence much current education policy, research and development. The Tavistock Report (Cullen *et al*, 2002) commissioned by the Economic and Social Research Council (ESRC), and which informed the third phase of the Teaching and Learning Research Programme (TLRP), notes that "a critical or reflective view on pedagogy in higher education is not widely found in the literature. Pedagogy is presented in technicist terms, rather than located in a social and philosophical space." It identifies constructivism as a "widely favoured approach to teaching, raising questions about the worth and validity of different kinds of knowledge and knowing." The authors of the report conclude "some academic teachers are taking a more critical, reflective view of their teaching and exploring the limits to constructivist approaches, or the circumstances in which it is an effective approach". The report authors appear oblivious to the evidence that, in the science education community, the value of constructivist pedagogy and epistemologies has been fiercely debated, and particularly so during the last decade. This may be explained by the fact that, although the authors of the Tavistock Report reviewed a large body of 'teaching and learning' literature, they did not include any science education literature from within the disciplines. This omission may be because the output by scientists actively involved in educating the next generation of scientists is regarded by educationalists as low-level action research/evaluation (Pedagogical Evaluation - Ped.E) that does not contribute to the philosophical/theoretical base of education (Pedagogical Research - Ped.R).

However, the neglect of output from within the disciplines means that a great deal of empirical work that illuminates what approaches *students* find effective, what engages them with their studies (Willmott, 2005), and how they develop ways of thinking and practicing (McCune and Hounsell, 2005) is missing from education debates. The Tavistock Report authors did, however, note a trend that is of particular concern for science educators. This was a "preoccupation with assessment and learning outcomes, and a marked decline in interest in the substantive content area of curriculum and its organisation. This is consistent with the dominant accountability agenda, but it also signifies a shift away from mastering knowledge towards the management of knowledge". This is hardly surprising since the technicist-rationalist thinking which informs Quality Assurance Agency (QAA) policies (Jackson, 2002a) and the post-modernism which informs current 'teaching and learning' theories do not invoke any theory of knowledge (Moore and Young, 2001). Hence disciplinary content is almost irrelevant - biology, for example, must make way for generic 'skills'.

Whether, as the Tavistock Report authors claim, there has been a "maturing in thinking about the choice of instructional strategies and methods to a current position in which the understanding of good practice is 'constructive alignment'" is certainly questionable in our opinion. They conclude "rather than 'good' (small group teaching, constructivist approaches), and 'bad' (lectures, transmissive approaches), appropriateness is now the key principle". Whilst this conclusion is welcome in suggesting greater flexibility, the apparent hegemony of constructivism and constructive alignment in the education policy research community, means that as scientists with a rapidly diminishing constituency in schools and HE we ought to address what the implementation of these strategies heralds for the future of the scientific disciplines. Against this background, the resurgence of constructivism – and alongside it, constructive alignment – deserves greater critical debate.

Constructivism and constructive alignment

At first sight the Tavistock Report appears to use ‘constructive’ in its everyday meaning of useful and helpful. But it is clear that Biggs uses the term constructivism to mean a theory of learning viz: “To my mind that means constructivism with its emphasis on what the students have to do, rather than on how they represent knowledge” (Biggs, 2003). In his foreword to Biggs’ book, Ramsden highlights Biggs’ pragmatism as to whether constructivism or phenomenography (as theories of learning that are focused on student activity) is the “way to go” and asks whether “academic (sic) differences between these two theories matter”.

The phenomenographic method is an alternative approach to the study of student learning (Richardson, 1999). Phenomenography, as a theory of learning has, almost without challenge, come to dominate the theory and practice of education developers in the UK and Australia, and some of its most notable proponents inform the thinking of the HE Academy. This new organisation has declared its commitment to enhancing the student experience in UK HE, basing its work on “the best available evidence” in delivering a coordinated approach to curriculum and pedagogic development. Even if readers are unfamiliar with the phenomenographic method, most will be familiar with its main output, the ‘deep - surface’ metaphor in respect of ‘good’ and ‘bad’ student learning, which has been universally adopted by education developers. Given the impact of ‘constructivism’ on science and science education and phenomenography on teaching and learning, we suggest that “academic (sic) differences between these two theories” do indeed matter, especially given their wide promotion as theories of learning by education developers. We also suggest that currently fashionable theories fail to take account of the cognitive norms and values of the disciplines as epistemic communities, and reliance on learning outcomes cannot ensure equitable standards for all students.

Constructive alignment and problem-based learning

Problem-based learning, a widely commended constructivist pedagogy, is claimed to be a teaching-learning approach with a high degree of alignment. The degree of alignment is said to be a key factor in its success in areas such as medical education in which it has been widely adopted (Biggs, 2003). The main reason for limited spread of PBL outside medicine is regarded as organisational in that it requires considerable institutional flexibility, rather than the reality that there are educational reasons for its limited adoption. Whether it is possible to have a constructivist pedagogy allied to a realist epistemology is an unresolved issue.

Some current examples illuminate the difficulties of constructivist views and pedagogies in medicine. The General Medical Council medical educational guidelines appear to regard all complementary therapies as valid, implying that a constructivist epistemology is implicit in a constructivist pedagogy (GMC, 2005). Recently, in the foreward to the Smallwood Report on Complementary and Alternative Medicine (CAM), commissioned by H.R.H. the Prince of Wales, the President of the GMC is of the opinion that “care must be respectful of and responsive to individual patient preferences, needs and values and ensure[ing] that patient values guide all clinical decisions" (Smallwood, 2005). In response, the Editor of the Lancet has warned that "the report contains dangerous nonsense" and "we are losing our grip on a rational scientific medicine that has brought benefits to millions, and which is now being eroded by the complicity of doctors who should know better" (Horton, 2005). An equally robust attack on the World Health Organisation (WHO) draft report on homoeopathy has been made by Ernst (MacCarthy, 2005). Ernst, Professor of Complementary Medicine at the University of Exeter, warns that [the WHO report] "seems overtly biased, i.e. it is based on data that are positive while 'forgetting' the negative studies and systematic reviews. The randomised clinical trials cited all happen to be positive, they are not the most rigorous ones, not the most recent. This does not inspire the reader to think the WHO report was ever intended to be objective. I find it terribly worrying because WHO shouldn't be promoting homoeopathy as it did acupuncture". It appears that in both the Smallwood Report and the WHO draft report, economically convenient constructs have been created that ignore objective scientific reality. Our concern is that constructivist approaches to science education and medical education are undermining the future science manpower base and producing less objective medical practitioners.

The debate on PBL in medicine is long running, with protagonists such as Colliver and Norman in the USA offering strongly contested views of the effectiveness of PBL (Colliver, 2000, 2002b; Norman and Schmidt, 2000). Norman, a long-term advocate of the benefits of PBL, recently agreed with Colliver, a long-term sceptic, that its proponents had oversold it and that unequivocal evidence for its benefits would never be forthcoming. The move to wholesale adoption of PBL in medical education in the UK has its sceptics (Williams and Lau, 2004) who doubt if it is possible to abandon formal teaching of the preclinical sciences and rely on "students learning about basic science by applying it in the context of real clinical problems" (Bligh *et al*, 2001). This situates basic science firmly as Mode 2 (transdisciplinary) and not Mode 1 (disciplinary) knowledge in the medical curriculum, and may account for anecdotal evidence of requests from junior doctors for formal teaching in anatomy, biochemistry, pharmacology, immunology, microbiology and pathology as continuing professional development. It is perhaps hardly surprising that Greenberg subtitled his introductory remarks to 'The Flight from Science and Reason' "Medicine Took an Earlier Flight" (Gross *et al*, 1996).

Norman and Schmidt (2000) went further "we continue to be astonished that researchers can attract funding for large, multi-centre, multi-megabuck trials of educational interventions. We are even more astonished, indeed distressed, to hear that the Campbell collaboration, the group which is on a research mission synthesis, plans to restrict their purview to large randomised trials of curriculum level interventions. Many decades of this genre have revealed a consistent result - no difference". The research into the effectiveness of PBL in nurse education undertaken in the second phase of the Teaching and Learning Research Programme (Newman, 2004) exemplified this approach. Such interventions are also problematic in terms of their empirical work which positions students as research subjects, in circumstances in which an educational intervention may disadvantage some students, as appears to have happened in this study. It is also unclear from the advice on determining learning outcomes, in the context of radical alignment positions which simply allow 'assessment to drive learning,' (Fowell and Bligh, 2001; Gibbs *et al* 2003), what strategies enable students to be given credit for originality, or outcomes which have not been defined in advance.

After more than 30 years of development and evaluation of PBL, there is still no unequivocal evidence that it has significant positive effects on student outcomes. Against this background with an expensive, highly aligned constructivist approach, we need to be very wary about promoting PBL, or other constructively aligned approaches, as ways of enhancing the student experience.

Alignment and learning outcomes - the death of originality and serendipity

A sector-wide policy of aligning all aspects of the curriculum to deliver stated learning outcomes seems, to us, to be inimical to science education - certainly in HE. The inevitability of some students producing 'learning outcomes' not identified by lecturers at the outset has been raised on numerous occasions. In problem-based learning, mismatches between learning outcomes not considered by staff but demonstrated by students have been identified frequently. Recently, Houghton (2004) has identified such outcomes in constructively aligned curricula as 'emergent outcomes' that need to be incorporated into course documentation as formal learning outcomes. Such an approach, in science at least, seems to be a recipe for continuous revision of course documentation to the point of absurdity.

Establishing minimal, threshold, learning outcomes that all students need to meet to achieve module/course credits is unproblematic and in accordance with subject benchmark statements (QAA, 2002). We might go further and establish advanced learning outcomes that we would expect better students to achieve; but to expect to be able to identify all possible learning outcomes for any but the most highly vocational courses must be both unnecessary and undesirable. For as long as we continue to assess student work as the work of individuals, and keep trying to identify and reward the exceptionally talented original thinkers, absolute alignment and strictly specified outcomes cannot be helpful. Indeed, for the majority of science educators, "perfectly reasonable deviations from the beaten track" (Feynman, 2005) are desirable outcomes, if difficult to pin down in prescriptive course documentation.

Constructive alignment and behaviourist approaches

Psychologists and educational developers advocating constructivism as learning theory, however, appear to take no account of disciplinary difference in the use of theory. Scientists argue that regardless of whether a realist or constructivist theory of knowledge informs what is learnt, learning happens by the same process, and that prescriptions on 'improving learning' are simply theories of instruction and irrelevant to constructivism either as a pedagogy or epistemology. Biggs himself is quite explicit that "constructive alignment is a design for teaching calculated to encourage deep engagement. In constructing aligned teaching, first it is necessary to specify the desired level or levels of understanding of the content in question. Stipulating the appropriate verbs of understanding helps us to do this. These verbs then become the target activities that students need to perform, and therefore for teaching methods to encourage, and for assessment tasks to address, in order to judge if or to what extent the students have been successful in meeting the objectives. This combination of constructivist theory and aligned instruction is the model of constructive alignment" (Biggs, 2003). The concept of "verbs of understanding" and their enactment as target activities for students is, for us and others, the least accessible and most problematic area of Biggs' construct (Prideaux, 2000). It is the salience of this concept for teaching at honours level in life sciences that eludes us, and we hope some empirical work could provoke debate in the biological science community.

Biggs acknowledges his debt to Tyler and bases the alignment component of constructive alignment on Cohen's reassessment of the behaviourist idea of instructional alignment (Biggs, 2002a; Tyler, 1949; Cohen, 1987). Curriculum objectives, teaching methods and assessment tasks are aligned leading, Cohen claimed, to "massive improvements" in the results of instruction. Instructional alignment ensures a precise match between what is taught, what is measured and what is intended to be learned, so that variation in pace of learning replaces variation in attainment, - the essence of competency based training (Talbot, 2004). In America in the 1970s, this 'teaching to the test' approach gained a foothold only in special needs education in schools, but later became embedded in adult training in the public sector, industry and business. However, what to teach and assess still remains the fundamental issue for Cohen, something we argue the 'teaching and learning' literature seldom considers. This literature also rarely, if ever, considers why students may want to engage with a subject out of interest rather than for instrumental reasons, whilst accepting their degree will possibly contribute little to their employment prospects.

Constructive alignment claims to negotiate the shift from behaviourist pedagogy to constructivist via the statement of curriculum objectives in terms of the level of understanding required of a student rather than a list of topics to be covered. However, we cannot reconcile this claim with admonitions to "get the students to do the things that the objectives nominate, -- and test to see if the students have learned what the objectives state they should be learning" (Biggs, 2003). Students are "trapped" into activities but free to construct the knowledge they may or may not acquire in the process, in their own way. This appears to us to be a constructivist epistemology, which is embedded in a behaviourist pedagogy. Requiring students to "enact verbs of understanding" (e.g. explain, classify, solve, analyse etc.) seems to us to be frankly behaviourist in terms of stimulus and response. Such a combination of pedagogy and epistemology would, we assume, privilege an elegant defence of intelligent design over a sparse but accurate account of evolution. That in the same week recently, two journals as diverse as Nature (Brumfiel, 2005) and the Tablet (Major, 2005) should have articles on intelligent design, both from the same editorial standpoint, is indicative of how divisive and contentious the field of evolutionary theory has become in schools and HE in the USA and Europe. It highlights our need as science educators to be explicit about our epistemological and pedagogic stance in respect of post-modern constructivist theorising on re-thinking science and research in terms of Mode 1 and Mode 2 knowledge (Gibbons *et al*, 1994).

There seems to be a diversity of interpretations of the idea of transdisciplinary knowledge (Mode 2) in the UK education policy community. The LTSN Generic Centre identified it with tacit knowledge of curriculum development in the Imaginative Curriculum Project, a frankly constructivist pedagogy (Jackson, 2002b). This project aspires to "support institutional work processes in which curricula are designed and developed and the social processes for professional learning by providing rich sources of information for the people who support, lead and facilitate these processes" - the very people in whom the tacit knowledge is claimed to inhere. Central to the notion of Mode 2 or socially distributed knowledge is "the idea that it cannot be authoritatively encoded in traditional forms of scholarly publication", and that it is not a process of application of prior knowledge in problem-solving. Mode 2 knowledge evolves in a "context of application in which solutions are generated locally to problems on an individual basis". (Nowotny *et al*, 2003). It is difficult to reconcile this with the production of web-based, context-free, generic guides. We do believe that the notion of the 'context of implication' in Mode 2 knowledge, however, is very relevant to mass higher education. A predictable, but unintended, consequence of the stratification of HE into those institutions offering education and a much larger number of training institutions producing employable, but unemployed or underemployed, young adults will surely be a debt-ridden, alienated generation caught in the 'opportunity trap' (Brown, 2003).

Constructivism, Science and Experts

Constructivism, in at least some of its forms, is profoundly unscientific and this may be a major contributory factor as to why constructivist approaches have given rise to such similar, long running, intensely contested debates in the chemical education community. (Bodner, 1986, 2004; Bodner *et al*, 2005; Hunter and Bodner, 2005; Scerri, 2003a, 2003b). From the perspective of scientists and science educators, some clarity on the meaning of the term 'constructivism' when used by educationalists should help individuals sign up to, or reject, the concept.

Constructivism in school science diverts attention from the need for well-qualified teachers. In higher education this is not the function of constructivism. Its political/managerial appeal appears to be the way it can be applied to the transformation of the scientific disciplines and those who teach, research and study in them, to respond to economic demands and the exigencies of mass higher education. The debate could be moved on by empirical work informed by university science educators, and by their involvement in a much more reflexive relationship with education researchers, as partners rather than as objects of phenomenographic investigation.

At the moment the relationship between education policy researchers and the disciplines is reminiscent of C.P.Snow's Two Cultures (Snow, 1993). The snobbery, anti-intellectualism and anti-scientific culture of Snow's era has been replaced post-Dearing by the marginalisation of both arts and science disciplines, and those who teach and research in them, as epistemic communities. At institutional and policy research level, they are conceptualised as possibly well-meaning but certainly in need of guidance from QAA, the HE Academy, ESRC and local education 'experts' about every aspect of teaching other than what to teach, (which is considered irrelevant anyway!). The status of the 'expert' in HE is readily accorded to some who have never taught or researched in HE, but who are, by proxy, only too well acquainted with the 'sage on the stage' and the 'bore on the floor'. We believe that a more fruitful relationship between policy researchers, education developers and lecturers could be conceptualised in terms of contributory and interactional expertise (Collins, 2004). As long as most education developers have no contributory expertise in relation to the scientific disciplines, and some scarcely any interactional expertise in the discourse of psychology and sociology they draw on for their advice on teaching and learning, they can hardly expect lecturers to engage seriously with them. How and what to teach is not a given, the field is one which is contested and open to negotiation. Policy researchers have been described as relying on uncertain means to achieve desirable ends (Bruner, 1996), but they need not necessarily "adopt to rivals, reduced to the state of objects, a point of view they are unable or unwilling to adopt towards themselves" (Bourdieu, 1984)

Conclusions

Against this background it is of considerable concern to us that the QAA has been identified as "the champion for constructive alignment" (Jackson, 2002a). A few HE Academy subject centres are uncritically hosting "constructive alignment - a guide for busy academics" whilst simultaneously advocating the "imaginative curriculum" project (Biggs, 2002a, 2002b; Jackson, 2002b). With such advocates as QAA, HE Academy and ESRC, constructivism seems unstoppable. Some, however, (Hounsell and Litjens, 2005; McCune and Hounsell, 2005) have suggested that curriculum alignment or curriculum congruence might be better, and philosophically more accurate, terms for what most academics have been doing for many years. With the well-argued case against constructivism in science (notably by Matthews, 2002, 2003; Scerri, 2003a, 2003b; and Koertge, 2000), science educators need to be aware of the implications of linking a damaging philosophy to otherwise sound approaches to curriculum design, development and delivery. In this way, they might avoid a marriage between a straightjacket of obsessive alignment, rigid pre-set learning outcomes and philosophical confusion.

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