Routledge
Taylor & Francis Group

Co-constructing an understanding of creativity in drama education that draws on neuropsychological concepts

Paul A. Howard-Jones[a]*, M. Winfield[b] and G. Crimmins[b]

[a]*Graduate School of Education, University of Bristol, UK;* [b]*Cardiff School of Education, University of Wales Institute Cardiff, UK*

Background: Neuroscience is unlikely to produce findings for immediate application in the classroom. The educational significance and practical implications of knowledge about mind and brain inevitably require some level of interpretation, yet the multiplying examples of unscientific 'brain-based' educational concepts suggest this process of interpretation is potentially problematic. Research is needed into the most appropriate ways of developing such concepts.
Purpose: This paper reports on an attempt to develop a process of 'co-construction' of pedagogical concepts, enriched by insights about the brain and the mind, with a group of trainee teachers led by a team with both educational and scientific expertise.
Sample, design and methods: A research team consisting of two teacher trainers and a psychologist followed an action research spiral involving 16 trainee teachers who explored their own creativity, and the psychology and cognitive neuroscience of creativity in seminars, discussions and practical workshops, with the pedagogical aim of developing their own reflective capability.
Results: Outcomes illustrated both dangers and opportunities associated with developing concepts bridging neuroscience and education. Trainees' understanding developed in stages that might broadly be described as initial enchantment, mythologising, disenchantment, an increased focus on metacognition and, finally, a demonstrable ability to reflect on their own classroom practice with a heightened sensitivity to issues of underlying cognitive processes.
Conclusions: The type of 'co-construction' process reported here may help reduce some of the more popular and problematic misconceptions that arise when developing pedagogical concepts involving the brain and mind. Further research is needed to assess impact of such concepts upon practice.

Keywords: creativity; drama; cognition; neuroscience

Introduction

An important area of challenge for the new interdisciplinary area of neuroscience and education is the culturing of pedagogical ideas that appropriately combine educational knowledge with concepts about the brain and the mind. History has already demonstrated how this can happen in a variety of unsatisfactory and often unscientific ways (see Geake, in this issue). As well as the practical usefulness of a pedagogic concept, the validity of any purported scientific basis for its validity is also an important issue, not least because many teachers would like to know not just what works, but why and how (Pickering and

---

Howard-Jones 2007). This understanding of underlying processes may also contribute to more effective implementation and evaluation. However, the production of credible concepts that span neuroscience and education may rely upon the development of improved communication and language, and the emergence of a two-way dialogue rather than a one-way transfer (Geake 2004). In the project described here, a process of co-construction is pursued by two educators (teacher trainers) and a psychologist with some educational and neuroscientific experience. We report upon efforts to collaborate within one particular context of teacher training, but it is hoped that the insights regarding the process of co-construction may be helpful in developing similar projects in other areas of education.

The chosen context for this study was the fostering of creativity in drama education. The potential complexity and diversity of creative processes made this a somewhat daunting context to work in. However, there is an increasing interest in creativity in the curriculum and a surprising lack of guidance available for trainee teachers in the fostering of creativity, especially in the field of drama education. It was this paucity of current research and understanding that provided the chief motivation for the project reported here which, in pedagogical terms, aimed to develop the reflective capability of trainee drama teachers in regard to the fostering of creativity, through a better awareness of the underlying cognitive and neurocognitive processes involved. Such an aim attends to the calls of those such as Chappell (2007), who has also highlighted the need within teacher training for an increased emphasis upon reflective practice in teaching for creativity. It should be noted, however, that the team did not intend to produce a pedagogical approach based solely upon scientific findings. The inadequacy of neuroscience (including cognitive neuroscience) to provide specific instructions for improving learning has been explored by a number of writers (e.g., Schumacher 2007; Davis 2004) and the team made several excursions during seminars to illustrate the limitations of scientific knowledge within education, when such knowledge is isolated from insights arising from other perspectives. Rather, the approach was to encourage trainees to broaden their reflections upon learning by *including* psycho-biological perspectives, and to provide them with a set of theoretical tools drawing on scientific insights that could be judiciously integrated with their own experience and those educational concepts they had already developed as part of their training.

Questions about the processes by which teachers and trainee teachers might successfully integrate their existing pedagogical knowledge and experience arose during efforts to pursue a wider multi-perspective cycle of research activity involving biological, social and experiential approaches to investigate creativity. This paper focuses only on this issue of developing practical and credible pedagogical concepts, but the wider cycle is reproduced in Figure 1, in order to illustrate the broader research contexts in which the study was undertaken. As part of the wider investigative effort, students attending the same BA course in Drama Education as our present participants had already been involved with a functional magnetic resonance imaging (fMRI) study of a strategy intended to foster creativity (Howard-Jones et al. 2005). (However, none of the trainees participating here had participated themselves in the fMRI study, or received any specialist knowledge of psychology or cognitive neuroscience as part of their under-graduate experience.) This fMRI study had focused upon 'random strategies' – i.e., strategies that require the incorporation of items into a creative outcome that are unrelated to each other and/or any context of the brief. As confirmed by the study, such strategies generally improve the perceived creativity of outcomes, but the fMRI results also showed increases in activity associated with creative effort. This supported the notion

Interdisciplinary dialogue: questions emerge → Neuroscientific investigation: fresh scientific insight

Reflective practice: Teachers take "ownership" of findings ← Experiential research: "insider" insights revealed
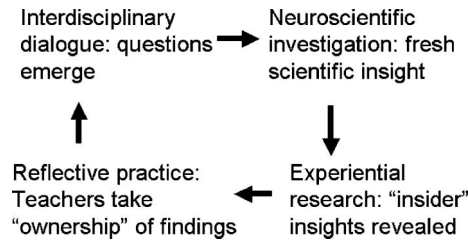
Figure 1. The work reported here is a part of a wider cycle of research activity aimed at increasing understanding about creativity, involving experimentation and more interpretative approaches. The cycle began by consulting with teachers and teacher trainers (top left) to help formulate hypotheses that might be tested using neuroscientific techniques such as functional magnetic resonance imaging (fMRI) (top right). Experiential investigations (bottom right) then examined issues from an 'insider' viewpoint, using theatrical workshops to explore aspects that scientific investigations find typically problematic, such as those associated with free-will and autonomy. Finally (bottom left), the findings from both the 'outsider' scientific studies and the 'insider' experiential investigations were taken forward to the present study, allowing practitioners, with expert support, to take ownership over findings in terms of their educational significance, using these and other findings to co-construct concepts that can support improved reflective practice. Such interdisciplinary dialogue may give rise to further potential research questions.

that the strategies encourage increased processing of a type associated with creative thought, rather than providing an effortless cognitive short-cut to improved ratings. By suggesting they encourage rehearsal of cognitive processes that we might call creative, the results support the likelihood of their being longer-term benefits to the learner. So, this fMRI study produced a finding that might be relevant to practice, but issues quickly arose when we considered how such a finding should be communicated back to educators. First, any individual scientific finding about creativity resides in the context of a larger body of knowledge from psychology and cognitive neuroscience and needs to be understood within that context. For example, without reference to related cognitive models, isolated biological images of blood flow in the brain may be distracting but have little to offer education (Bruer 1997). It was clear that the 'translation' of neuroscientific understanding to the classroom would be fraught with dangers of unscientific interpretation and/or departure from a grounded educational understanding. Building any useful conceptual bridge that spans neuroscience and education would require communication of broader issues and concepts, and co-construction of understanding by those with expertise on both sides. Therefore, in addition to the pedagogical aim identified above, the research aim of the project was to provide an improved understanding of this process of co-construction, since this might be helpful to any future ventures integrating neuroscience and education.

Method

The research team consisted of two teacher trainers and the neuroeducational researcher who directed the original fMRI study. The methods used to communicate concepts and the details of the content covered in sessions was negotiated between members of the research team and informed by the responses of the trainees as the project progressed. In terms of content, note was made of what trainees found useful in terms of understanding their own and their pupils' experiences and learning. In terms of developing communication methods, the research team took particular note of the appropriateness, relevance and validity of the ideas expressed by trainees during sessions.

Sixteen trainee teachers, in the second year of their training, voluntarily took part in what was advertised as a short program of seminars and activity-based workshops exploring concepts about creativity. An action research spiral (Elliot 1991) was followed by the researchers (Figure 2) consisting of an initial meeting of the research team and initial discussion with the trainee teachers, followed by three cycles of research meeting, seminar, workshop and student discussion, ending in a final meeting of the team to reflect upon the project as a whole. Workshops, seminars and trainee discussions were video taped, with informed written permission from the participants. After each of these events, an analysis of the video data was used as a basis for discussions during subsequent research team meetings that deliberated upon progress and revised future plans (see Figure 2). An audio recording was made of these research team meetings and this was transcribed to help track the issues raised and decisions made.

Results and analysis

The processes by which pedagogical concepts were constructed are now reported upon in the chronological order in which they occurred, beginning with data arising from the preliminary discussion with the students, followed by each of the three cycles of activity in turn.

Initial discussion with trainees about how to foster their pupils' creativity

Before introducing any new concepts, we had an initial discussion with the trainees that provided some sense of baseline regarding existing ideas about creativity. As observed by Hayes (2004), although the term 'creativity' is frequently used, its direct definition remains problematic, with recent attempts emphasising the role of factors beyond the level of the individual, and issues of ethics and morality (e.g., Craft 2000, 2006). In the initial discussions, the team drew on a simple definition of creativity as the type of imaginative thinking that produces an outcome possessing some level of originality, as well as some
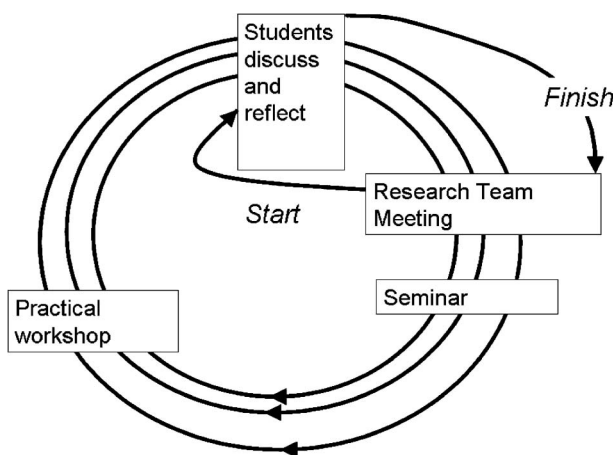

Figure 2.   The action research spiral followed by the researchers. After an initial meeting of the research team and discussion with the student participants (trainee teachers), there were three cycles of research meeting, seminar, workshop and discussion with participants, ending with a final meeting of the research team to reflect upon the project as a whole.

sense of value (NACCCE 1999). Trainees felt comfortable with this definition and expressed strong personal convictions about the importance of creativity, a capability that enriched many parts of their lives and was especially appreciated in drama education. Many had chosen to become drama teachers because, as pupils themselves, they had discovered drama was a subject area that embraced creativity. However, creativity was generally seen as a spontaneous process mostly beyond influence and that should simply be allowed to flourish:

> Kids they just – they draw so many things from so many places, and they can bring it all together and they can – and there's your creativity – you can't teach it.

Trainees generally emphasised a 'hands-off' notion of creativity as a type of thinking that appeared in the absence of poor teaching rather than resulting from good teaching. This was evident in the frequent use of phrases such as 'you're allowing them to be creative'.

First cycle

The team agreed that the first priority would be to present a simple cognitive model of creativity. The model used was originally developed to support the teaching of design (Howard-Jones 2002) and describes creative cognition as involving two modes of thinking: generative (G) and analytical (A). The model emphasises the difference between thought processes we use to critically evaluate an outcome and those we use to generate it in the first place, the latter requiring access to concepts that are more remotely associated with the matter at hand. When engaged in analytical thinking, an individual is expected to be focused and to constrain their attention upon the analysis. However, when accessing remote associates, there is benefit from being less focused and allowing attention to drift towards concepts that have not previously been directly associated with the problem. Analytical thinking can also be useful elsewhere in the creative process, such as when researching a topic or context before generating any ideas. Creativity, then, may be characterised by an ability to move from one mode of thought to the other without difficulty. The existence of two distinct modes of thinking is not a new one, but builds on the ideas of Ernst Kris (1952), Wundt (1896) and Werner (1948).

After being introduced to this model of creative cognition, trainees were presented with research illustrating how the conditions for supporting analytical and generative thinking can be quite different. They were reminded how our analytic abilities can often be supported by being encouraged to remain focused, being offered some monetary reward for our performance or by the mild stress of knowing we may be evaluated and assessed. Generative ability, on the other hand, can benefit from changes in context (Howard-Jones and Murray 2003), tasks that require divergent semantic association (Howard-Jones et al. 2005), intrinsic motivations such as fascination and curiosity (Cooper and Jayatilaka 2006) and relaxation (Forgays and Forgays 1992). Production of a single creative idea can require alternation between a focused analytical state when exploring what is known about an issue, a generative state when finding associations beyond the context of the issue itself and a return to the analytical state to assess the value of what has been generated. However, even in the production of a very short story, more complex trajectories between these two modes of thinking can be assumed.

To understand how the creativity of pupils can be directly influenced by a teacher, trainees were introduced to 'random strategies' that require the making of links between elements chosen with some degree of randomness. In the fMRI study discussed in the Introduction to this paper, the neural correlates of creativity in a storytelling task were

identified by comparing brain activity when trainees were trying to be creative and to be uncreative as they produced their story (Howard-Jones et al. 2005). Participants had to include a different set of three words for each story. The activity in some areas associated with this creative effort increased further when the words were chosen with some degree of randomness and thus were unrelated to one another. (The creativity of such stories, as assessed by an independent panel of judges, also increased as expected.) The chief area in which correlates of creative effort increased when using this strategy was the right medial gyrus – an area associated with higher-level conscious control, presumably due to increased amounts of filtering out of inappropriate combinations of ideas. So, although the strategy encouraged greater generation of ideas, it may also have required increased amounts of conscious analysis and effort.

In the discussion that followed the seminar, considerable enthusiasm was expressed for using what we know about the brain and mind to enrich pedagogy. Much of the dialogue focused on the fMRI study. The power of brain-imaging to engage interest is well known and research has shown that it stimulates a sense of objective evidence and a 'physicalisation' of concepts of the mind (Cohn 2004). There are attendant dangers in this interest, such as it encouraging notions of static brain states characterised by activity that is restricted to a few limited areas. However, as observed here, it can help 'concretise' psychological concepts that might otherwise remain too abstract to be taken up by non-specialists. Trainees were keen to find real-world analogies with the fMRI experimental task and resonances with their own experience. A trainee reported how she had recently asked every pupil in her class to construct a story around any two of four items: a map, a set of car keys, a ballet shoe and a bottle. Two of these items – i.e., the map and car keys – seemed more obviously related and she noticed the effect on the pupils' creativity:

> the majority of people in the class chose the map and the keys and there were just different variations of car crashes and that was pretty much all they came up with, and the bottle and the ballet shoe – that really worked a lot more creatively.

These observations were, at first, simple behavioural cause–effect links, without any great reference to underlying cognitive processes, and echoing some of the ideas raised in the initial discussion. For example, the trainees, again, seemed to refer to creativity as a spontaneous process, but now as one which required the right level of constraint – not so constrained that it cannot flourish, but requiring enough guidance to provide reassurance. Such ideas have been expressed in studies of creativity in dance education, as a balance between control and freedom (Chappell 2007). It appeared that the trainees' ideas about creativity were becoming more sophisticated, as they suggested that their own creativity sometimes depended on the right level of constraint being provided by their tutor. One trainee reflected upon how she would have felt when performing a particular exercise with such guidance:

> I would have found it quite overwhelming, and I think I would have felt the need to impose guidelines upon myself, but if it's too constrained, then it stifles the creativity and you just don't have the kind of scope required for the kind of work and outcome you want to have.

The idea arose that individual differences existed among learners as to the level of constraint they needed, and this was not necessarily related to academic ability:

> We had a group of super-intelligent girls who sat there for 40 minutes really mulling it over and one of the boys just said to them, 'er . . . why don't you do the title "the day I went mad with a spade"?', and they said '*that's it!*' and started writing.

The team suggested that perhaps these girls had been too analytical in their approach and become fixated. Fixation, when one idea or set of ideas becomes overly dominant, had been discussed in the seminar. This prompted the trainees to consider how thinking about creativity in cognitive terms might call into question some aspects of accepted practice, such as target setting and indicating learning outcomes at the beginning of a lesson:

> if you're telling them that at the end of the lesson they're going to be doing a performance, then straight away they're not in generative mode anymore.

As the trainees began to focus more upon underlying cognition, one voiced a realisation that such reflection could radically change their perceptions and their strategy:

> as soon as you build an understanding of how people work, and why they work like that, then you don't necessarily see someone's behaviour in the same way.

A practical workshop followed these discussions. This was aimed at providing trainees with experiences that could later, with support, be linked to some of the scientific concepts of mind and brain they had been introduced to. The workshop included an attempt at identifying what is creative by considering what is perceived as uncreative. Repetition, lack of originality and a tendency towards 'what is obvious' were characteristics that were deemed uncreative. Trainees engaged very actively in this discussion, in contrast to their participation in the next activity, 'Babble', which was a verbal improvisation exercise invented by the team. In 'Babble', students were invited to improvise dialogue by building incrementally from speech-like sounds, through unrelated words to snippets of sentences until they developed a conversation. The team had intended the trainees to engage with the exercise as a form of purposeful play, but the students took up suggestive cues and avoided deviating from them, apparently feeling more comfortable with the type of 'tight apprenticeship' model of learning described by Chappell (2006). However, the team's lack of success in engaging them with this exercise also provided a useful topic for later discussion. It was introduced with few 'rules' and without any physical or imaginative warm-up activity. The subsequent parts of the workshop were more successful. 'Ever-evolving statue' was a familiar physical improvisation exercise in which trainees were required to create physical postures in relation to one another's body positions and shapes. This built from working in pairs to fours to groups of eight. Postures relating to character or narrative development were discouraged in favour of kinaesthetically imaginative interaction. This exercise encouraged trainees to make links echoing the fMRI study, essentially making connections between disparate elements. A 'group morphing' activity provided a movement equivalent of this exercise, and an object improvisation exercise provided another such potential cross-reference between science and experience.

This workshop provided common foci for first reflections upon how ideas emerge. The research team noted the likely importance in developing the trainees' understanding of being able to identify transitions between G and A modes of thinking. So, after the workshop, trainees were asked to produce a line graph indicating where they had been along the G/A continuum at various points in the workshop. Outcomes were very varied but the process prompted trainees to begin reflecting upon their own creative cognitive processes:

> in the last task, you were able to be very, like ... um, generative in the process of creating. And then ... because we were in a group and we knew we had to perform ... we had to bring it back and be, like, analytical ... so my last line is going up and down. We did go back and look at what we were doing ... [laughter], but obviously not enough!

Trainees discussed the ease with which thinking can tend to the obvious, and how it feels when the obvious option is made less available. For example, trainees commented that the items they had selected themselves appeared to them already connected, and they had often begun making a story with them at once. When trainees were required to improvise by linking together unrelated objects selected by the research team, the task became more challenging and difficult, possibly reflecting the additional frontal medial activity observed in the fMRI study of semantic divergence:

> I felt really limited by the fact that you'd given us objects and the fact that we couldn't choose our own . . . I felt really like I'd hit a wall and was going to have to really think about how I was going to move on.

The trainees identified that a lack of warm-up had contributed to the first ('Babble') exercise going astray, suggesting they needed a way of clearing away some of the unwanted foci of the day to make space for new ideas. There was a sense that everyone had been too willing to focus on the smallest suggestion of a context – a party – and become fixated on it. The trainees then became excited by the importance of relaxation and the generative state, and also discussed how planning one's actions can sometimes diminish generation of ideas. This gave rise to the idea that planning, in which one sets out the stages by which one will achieve a goal, can encourage a particular mind set that discourages generation of new directions and ideas. The trainees appeared comfortable classifying *tasks* as being creative or uncreative and seemed to avoid considering whether they supported the type of thinking required in a particular context. For example, one trainee had begun believing that planning always diminished creativity and the inclusion of randomness always increased it:

> I've got it into my head now that to be uncreative you plan and stuff – so now I think that the last improvisation we did was completely uncreative because I planned it! Because we discussed it as a group and I don't know, now, I'm all confused . . . I think that the last task was more random . . . you gave us lots of randomness.

The team gave examples of how different levels of planning can be good or bad for creativity depending on aspects of the situation such as the individuals involved and the types of cognition one might wish to encourage at a particular stage in a creative process. The generative part of creativity had been the main focus of discussion but the team felt it was important to remind them that analysis was also needed. The creative process, as described by Wallas (1926), was presented as a shift from analytical to generative and back to analytical.

Second cycle

There was a clear tendency emerging for trainees to make short cuts from strategies to outcomes without consideration of underlying cognitive processes and context. We needed to diminish the temptation to classify strategies as creative or uncreative, and to encourage the trainees to think more about the appropriateness of strategies in terms of the cognitive processes and whether, in terms of the context, these might be helpful in progress towards creative targets. It was clear that some of the students felt daunted by this task. The team identified the abstract nature of the cognitive concepts involved as a potential challenge for some. We wanted to make the cognitive model of creativity we had been referring to more concrete for the trainees. The trainees had been notably fascinated by a neuroscientific case study mentioned previously by the team, so it was decided to detail two such studies

in the next seminar to illustrate extreme examples of the two modes of thinking. This was felt appropriate in the context of training teachers, but the use of such case studies with children would clearly raise some ethical issues. The team felt that classroom discussions about disorders of the mind might easily lead to misconceptions that could distress/confuse some pupils, if teachers leading the discussions were not versed in the necessary expertise.

In the next seminar, the trainees were introduced to a part of the brain called the cingulate cortex – an island of the cortex below the external surface of the brain. The front (anterior) part of this region shares a controlling function with the frontal lobes and is associated with executive attention – the cognitive mechanism by which we control the focus of our attention (Gehring and Knight 2000). Hyperactivity in this area has been associated with Obsessive Compulsive Disorder (OCD) and the associated preoccupation of sufferers with correcting perceived mistakes (Fitzgerald et al. 2005). The trainees were played an interview with a sufferer of OCD, who described her ritualistic repetitive routines. It was discussed how this type of rehearsal resembled the analytical and evaluative rehearsal processes used to hone a piece of creative work, but taken to an obsessive and very uncreative extreme. It was as if sufferers of OCD are caught in an analytical mode of thinking. In contrast, the team then presented a case of compulsive creativity (Lythgoe et al. 2005). The trainees were told that Tommy was a 51-year-old builder with no previous interest in the arts, who suffered a subarachnoid haemorrhage – a bleeding in the space around the front of the brain – resulting in frontal dysfunction. In the weeks following his injury, Tommy became a prolific artist. He first began filling notebooks with poetry, then began sketching and in the following months produced large-scale drawings on the walls of his house, sometimes filling whole rooms. His artistry continues to this day and has become more developed. Tommy cannot stop generating material, often only sleeping 2–3 hours a night between days filled with sculpting and painting. He shows verbal disinhibition, albeit creatively, by constantly talking in rhyming couplets and there are some signs of impaired executive function. Trainees discussed how Tommy appeared to be caught in a generative mode of thinking. Trainees listened to an interview with Tommy who explained what his world was like and they read a poem, 'Brain explorer – it's for you', that he had written for the author of his case study. The team hoped that listening to the voices of those suffering from very generative or analytical mental states would help characterise these modes of thinking more clearly for the trainees and support them in monitoring their own modes of thinking.

In the improvisational exercises that followed, trainees were occasionally interrupted and asked to hold up G or A cards to indicate their current mode of thinking. The first two exercise was 'talk for a minute', in which they had to speak without pause or hesitation on a topic chosen for them. That was followed by a 'delayed copying' exercise in which students had to continuously reproduce not the movement just made by the leader, but the movement previous to it. Trainees almost always held up the generative card when interrupted during the first exercise and the analytical card during the second. When talking-for-a-minute, trainees generated ideas with little time to reflect and reject unsatisfactory elements. When copying movements, trainees focused on a very specific routine, analysed what they saw and rehearsed this mentally before reproducing it. A more complex task followed called 'story in the round', in which trainees sat in a circle and, when asked, had to continue the story their neighbour had been telling. This produced a spread of A's and G's, which trainees explained in terms of individual differences in approach, but also according to where in their own creative process they were when asked to report. Trainees often held up a 'G' when generating links between their ideas and the

story their neighbour was telling, or produced an 'A' when evaluating possible stories or those they were hearing. 'Tag improvisation', in which trainees had to step into an improvisation and take over from another performer, also provided an example of this complexity.

Trainees were then asked to produce a piece of movement using the textures and sounds they had encountered during an imaginary journey into a magic wardrobe. Researchers observed and interrupted when they identified points of transition, asking whether trainees were aware that a transition had occurred and whether they could explain why it had happened. Although some trainees had been initially unaware that transitions were even occurring, they quickly began recognising them. They often chose to explain them in terms of a need to move from one mode of thinking to the other. Transitions to rehearsal were often justified in terms of a need to evaluate and hone what had been generated, and thus any attempt to run through the work in progress was usually seen as a return to a more analytical thinking mode. This was something of a turning-point in the project, and the subsequent discussion developed a new richness and depth in terms of the trainees thinking about their experiences in the workshop itself and also their teaching.

Trainees began talking in reflective and often emotional terms about generating and analysing material. Generative processes were described in both positive and negative terms, as highly pleasurable but also slightly frightening. One trainee also described how analytical rehearsal, as in OCD, can become an unhelpful response to anxiety – i.e., the apprehension of having to generate ideas:

> when I'm creating work I feel like I have to keep going back, and like you said: 'what would happen if I didn't go back?' I don't know, but that's what I'm too afraid to find out, I couldn't just keep on creating.

The generative process was described as 'scary', 'like a void' but also as a 'delight', with the workshop reminding trainees how much they enjoyed being generative. Again, the spontaneous nature of creativity that had been mentioned in the earliest session arose, but this time spontaneity was assigned to a particular part of creativity: the ability to generate. The trainees had observed how young children can be highly generative in their thinking, although often less developed in their ability to critically rehearse their ideas. Adults, on the other hand, often find it difficult to maintain such effortless generation of ideas, needing instead to pause, analyse and refine meaning:

> when you told us to talk for a minute, I think the poem [by Tommy] is what we find so hard to do. Like in the poem where there's no links, you said to us don't worry about the links, but automatically everybody tried to make a story even when you'd told us that we didn't need to.

Metacognitive awareness, to the extent of regulating as well as monitoring cognitive processes, became evident:

> I started off by being analytical, thinking: 'What am I expected to get out of it? What am I supposed to be doing with this visualisation?' And then I just thought, 'No, right, cut that off, just leave it, let it go, and just made myself switch off that'.

Interjection by the research team during salient moments of transition not only raised awareness of cognition, but also appeared to encourage self-regulation:

> I knew I was trying to change it, and I knew you'd go, 'Why?' . . . but then I'd go, 'Oh, I'm being too analytical, let's just change it, let's just go with something different and not keep knocking our head against this brick wall'.

Third cycle

At the next research meeting, the team selected two pieces of footage from previous workshops that would be suitable for analysis with the trainees at the next seminar. At this final seminar, the team first showed footage of the failed 'Babble' exercise from the first workshop, and some excerpts from the discussion with trainees that had followed it. In reflecting upon the outcomes of the exercise, trainees watched themselves improvising on film and afterwards discussed the considerable repetition within and between individuals, the regular occurrences of blocking during the improvised dialogue and a tendency towards fixating upon cues from the team, and noted the feelings of discomfort and obligation that had been discussed afterwards. In understanding why the exercise had not succeeded in generating ideas, discussion centred on feelings of anxiety about not knowing what was required and the lack of a relaxation exercises. Additionally, the preceding tasks had been very analytical in their goal, including analysis of the term 'uncreative' and writing an 'uncreative' story which most students achieved by the self-imposition of constrained boundaries and use of frequent repetition. This may have impacted on generative tendencies in the subsequent exercise, a type of transfer that has been observed elsewhere (e.g., Howard-Jones, Taylor, and Sutton 2002). It was discussed whether seeing a member of the team carry out the task first would have helped. This gave rise to a discussion about mirror neurons which, it has been speculated, may provide a basis for the embodiment of cognition and even the unconscious communication of mental states (Rizzolatti et al. 2002).

Options were considered regarding what might have been done after the failure of this exercise. The trainees were asked: 'Should we have stopped and evaluated what had gone wrong?' 'Should we have gone into some relaxation exercises?' 'Should we have just ploughed on to the next exercise?' It was agreed that an evaluative exercise would probably have further entrenched everyone in an analytical mode of thinking. Recalling the effects of relaxation on free association (Forgays and Forgays 1992), there appeared a clear case for relaxation exercises. Continuing directly on to the next exercise (which is what actually happened) was the more uncertain course which, as it turned out, worked well. The trainees were then asked to consider why it might be that this subsequent exercise (object improvisation) did work better. Three issues emerged from the discussion. First, it was a familiar exercise and the trainees immediately felt more relaxed. Second, the task required links to be made between objects that the trainees had not selected themselves. Third, the trainees felt they had time within the exercise to produce ideas which, as discussed above, may be needed in order to select appropriate links between elements that are disparate. So, the trainees were asked: 'If this was your class and you found one group was staying focused on the brief, asking a lot of questions about boundaries and unable to generate ideas beyond the obvious, what would you do?' Alternatively: 'If another group rushed straight into the improvisation and were generating a lot of incoherent ideas that were not being developed appropriately, what would you do?' In this way, the trainees were encouraged to start thinking about their effect, as teachers, on the creative cognitive processes of their pupils.

After this session on analysis, the trainees were 'hot-seated' about reflections on their own practice. Volunteers took turns to sit in front of the group and recall specific instances in their own practice for discussion and analysis by the group, which now often included reference to their pupils' modes of thinking. For example, it was discussed how questions about procedure and process often reflected an insecure adherence to analytical processes, and how the confidence to create was often accompanied by a diminishment in questioning the teacher. Lower-ability groups often suffer from this lack of confidence, and another

trainee drew attention to how a teacher's response to questioning can also be used to orientate pupils' modes of thinking. This trainee described how she used 'teacher-in-role' and then prompted pupils' interpretations. Questions from the class about whether their idea was correct were deflected by the response 'it's whatever you think it is', leaving the arena open for other pupils while legitimising all suggestions as valid self-generated ideas. At first it was the louder children who were questioning her for the right answer, but then, when it was clear that none existed, the quieter children came forward with their ideas. The use of 'teacher-in-role' prompted many other accounts of how pupils can be directed towards a particular mind state through imitation, again producing references to the concept of mirror neurons. For example:

> they'd got to the point where, you know, they hadn't got much and what they had got was very limited and it was very clichéd ... they couldn't seem to generate ideas ...[but] they worked so much better when we showed that we were willing to generate ideas too.

There was a sense in which acting and generating in front of the children communicated both the types of mental processes required and their legitimacy:

> I can't do it wrong if I do what she's done ... so it's OK, I can take part in this now ...I can allow myself to be generative, even though people have told me I'm wrong before, this can't be wrong now.

Trainees spoke of there being transitions within a lesson, describing some lessons as 'like a sandwich' of thinking modes. They also discussed how transitions between dominant modes of thinking could sometimes be helpfully positioned at the boundary between lessons. Trainees also referred to instances when changing context and suspending evaluation had succeeded in dissipating fixated mind sets. Working with others was also seen as a valuable way of encouraging children to make links, including those links between interpretations of their own and others' ideas:

> but also working with other people and seeing what they do and taking your own interpretation of what they do – because they don't explain what they're doing and what they're saying – that, in turn, helps you generate ideas ... like with the Rorschach tests with the ink splots – what do you think you see? – you take your own interpretation and that helps you create your own mental links which puts you on further in the generative process.

Perhaps unsurprisingly, although the team had been at pains to point out that this was not the case, there remained a natural tendency for some trainees to assume a simple functional-anatomical mapping of cognitive processes, including those associated with generative and analytical modes of thinking:

> You're using almost two different parts of the brain there to do it, so like separating them into generative now and analytical at a different time ... so trying to switch.

Finally, the teacher trainees and their trainers were asked what they had got out of this experience of reflecting upon their practice in terms of psychological and neuropsychological concepts. First, there was a sense of having an improved theoretical understanding that supported existing practice, especially in terms of the role of 'warm ups'. Secondly, the trainees expressed a sense of being more empowered to intervene and support children's creative cognitive processes:

> so that when you go into the classroom, you can identify the different states, you know, that you can then manipulate or change it, and what's the point of that change. You as a teacher

can then change their way of thinking and make a more productive learning environment for your pupils.

Trainees referred to a number of issues influencing creativity that they felt provided insights into their own practice, and overall there appeared a new sense of responsibility for fostering abilities they had initially considered as entirely spontaneous and not amenable to teacher intervention:

> not all children/pupils/adults find it that easy to be creative, then when we go into schools, you can't just expect them to just improvise, just 'cos we can do it. It's up to us as teachers, then, to differentiate.

Issues regarding the difficulty in combining the language and perspective of natural science with educational thinking remained salient even in this final discussion, as some trainees struggled to find the appropriate terms by which to express their thoughts:

> Trainee: I think its reawakened (1) my curiosity, and (2) some previous revelations about environment and the effects that it has on people, and what they're capable of doing and how – and this is the only way I can think of saying it, how you can psychologically manipulate [laughter] – there's probably a better way to say it!
> Other [suggesting]: ' . . . effect change?'
> Trainee: That's the one . . . [laughter], but you can look at and influence the environment and [thereby] people's way of thinking, and how to change that, and get the best out of people by doing that.

Conclusion

Overall, during this short intervention, the trainee teachers showed progression in their attention to, and understanding of, creative cognition in the classroom. This progression passed through stages that included:

(1) an initial high degree of enthusiasm.
(2) a flourishing of initial behavioural and conveniently prescriptive neuromyths.
(3) a daunting realisation that things were more complex and required attention to cognition.
(4) increase in meta-cognition, with neuroscience helping to 'biologise', 'concretise' and deepen concepts.
(5) emergence of concepts, language and reflective capability that allows deeper reflection, sensitivity and insights around personal practice in specific contexts, in terms of mind and brain.

Trainees' efforts to understand their own personal experiences of learning/creativity in terms of underlying cognitive processes appeared an important step in developing related insights into their teaching practice. Trainees sought to apply their new understanding in a variety of areas, including environmental effects and issues around the planning of activities such as the sequence of events and providing for individual differences. fMRI and other research involving imaging can be very effective in engaging non-specialists with thinking about the mind and the brain although, with this power to engage, also arise attendant dangers of encouraging myths such as simplistic phrenology. It was also found that neuroscientific case studies had a role in helping trainee teachers understand the mind and the brain, although their appropriateness as a more general teaching tool in the area of education may need further ethical consideration.

Here we have reported on an exploratory study that focused on the process by which pedagogical concepts can be co-constructed across neuroscience and education. We have not reported in any detail on the concepts developed (see Howard-Jones 2008) and these have not been formally evaluated. If such ideas are, as we hope, an improvement on the many 'brain-based' learning ideas presently being marketed, several issues will still need to be considered in determining their value, two of which deserve mentioning here. First, scientific knowledge of the mind and brain will always be partial and pedagogical ideas that draw on such knowledge will always require continuous updating and improvement. For example, the trainees were encouraged to use research findings to gain reflective insight into the creative behaviour of their pupils. However, the fMRI studies of 'normal' cognitive function presented to the trainees had been carried out with adults, whereas children's cognitive and neural processes may differ significantly from those of adults. As research on mind and brain progresses, these differences will inevitably need to be considered in terms of their pedagogical implications. Related to such considerations, trainees judged the understanding they had gained to be useful and it appeared to improve their ability to reflect on their practice, but its value in terms of improving practice still requires further investigation. We tentatively suggest that the concepts developed from a project such as ours could provide a helpful and stimulating contribution to teachers' systematic enquiries into their own practice. Such enquiries, which help develop teachers as reflective learners, are considered in themselves to be an important ingredient of effective teaching and learning (Hofkins 2007).

In our project, insights about mind and brain successfully highlighted a general message about how creativity involves a generative mode of thinking that is essentially different to the analytical mode predominant in school education. On the other hand, as was emphasised to the trainees, it is clear that individual creativity will always be a journey whose destination is unknown. Every creative journey is a unique experience, just as every brain is unique in terms of both its structure and functioning. For these reasons alone, neuroscience cannot entirely explain or demystify creative cognition and experience. However, using a process of co-construction that attends to both educational and scientific perspectives may produce new ways to think and talk about creativity and, in this way, help us to reflect upon the daily decisions we make as educators when fostering creativity in our students.

Acknowledgement

References

Bruer, J.T. 1997. Education and the brain: A bridge too far. *Educational Researcher* 26, no. 8: 4–16.
Chappell, K. 2007. The dilemmas of teaching for creativity: Insights from expert specialist dance teachers. *Thinking Skills and Creativity* 2, no. 1: 29–56.
Cohn, S. 2004. Increasing resolution, intensifying ambiguity: An ethnographic account of seeing life in brain. *Economy and Society* 33, no. 1: 52–76.
Cooper, R.B., and B. Jayatilaka. 2006. Group creativity: The effects of extrinsic, intrinsic, and obligation motivations. *Creativity Research Journal* 18, no. 2: 153–72.
Craft, A. 2000. *Creativity across the primary curriculum: Framing and developing practice*. London: Routledge.
———. 2006. Fostering creativity with wisdom. *Cambridge Journal of Education* 26, no. 3: 337–50.
Davis, A. 2004. The credentials of brain-based learning. *Journal of Philosophy of Education* 38, no. 1: 21–35.
Elliot, J. 1991. *Action research for educational change*. Buckingham: Open University Press.

Fitzgerald, K.D., R.C. Welsh, W.J. Gehring, J.L. Abelson, J.A. Himle, I. Liberzon, and S.F. Taylor. 2005. Error-related hyperactivity of the anterior cingulate cortex in obsessive-compulsive disorder. *Biological Psychiatry* 57: 287–94.

Forgays, D.G., and D.K. Forgays. 1992. Creativity enhancement through floatation isolation. *Journal of Environmental Psychology* 12: 329–35.

Geake, J.G. 2004. Cognitive neuroscience and education: Two-way traffic or one-way street?. *Westminster Studies in Education* 27, no. 1: 87–98.

Gehring, W.J., and R.T. Knight. 2000. Prefrontal-cingulate interactions in acion monitoring. *Nature Neuroscience* 3, no. 5: 516–20.

Hayes, D. 2004. Understanding creativity and its implications for schools. *Improving Schools* 7, no. 3: 279–86.

Hofkins, D. 2007. What's the evidence? In *Principles into practice: A teacher's guide to research evidence on teaching and learning*, ed. TLRP, 14–16. London: TLRP.

Howard-Jones, P.A. 2002. A dual-state model of creative cognition for supporting strategies that foster creativity in the classroom. *International Journal of Technology and Design Education* 12, no. 3: 215–26.

———. 2008. *Fostering creative thinking: Co-constructed insights from neuroscience and education*. Bristol: Escalate. http://escalate.ac.uk/4389.

Howard-Jones, P.A., S.J. Blakemore, E. Samuel, I.R. Summers, and G. Claxton. 2005. Semantic divergence and creative story generation: An fMRI investigation. *Cognitive Brain Research* 25: 240–50.

Howard-Jones, P.A., and S. Murray. 2003. Ideational productivity, focus of attention and context. *Creativity Research Journal* 15, no. 2/3: 153–66.

Howard-Jones, P.A., J. Taylor, and L. Sutton. 2002. The effects of play on the creativity of young children. *Early Child Development and Care* 172, no. 4: 323–8.

Kris, E. 1952. *Psychoanalytic explorations in art*. New York: International Universities Press.

Lythgoe, M.F.X., T.A. Pollak, M. Kalmus, M. de Haan, and W. Khean Chong. 2005. Obsessive, prolific artistic output following subarachnoid haemorrhage. *Neurology* 64: 397–8.

National Advisory Committee on Creative and Cultural Education (NACCCE). 1999. *All our futures: Creativity, culture and education*. London: Department for Education and Employment.

Pickering, S.J., and P.A. Howard-Jones. 2007. Educators' views of the role of neuroscience in education: A study of UK and international perspectives. *Mind, Brain and Education* 1, no. 3: 109–13.

Rizzolatti, G., L. Fadiga, L. Fogassi, and V. Gallese. 2002. From mirror neurons to imitation: Facts and speculations. In *The imitative mind: Development, evolution, and brain bases*, ed. A.N. Meltzoff and W. Prinz, 247–66. New York: Cambridge University Press.

Schumacher, R. 2007. The brain is not enough: Potential and limits in integrating neuroscience and pedagogy. *Analyse and Kritik* 29, no. 1: 38–46.

Wallas, G. 1926. *The art of thought*. New York: Harcourt, Brace & World.

Werner, H. 1948. *Comparative psychology of mental development*. New York: International Universities Press.

Wundt, W. 1896. *Lectures on human and animal psychology*. New York: Macmillan.