Neurodiversity and Fostering Creativity Through Assessment: Issues for Computing Students in Higher Education

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Abstract – Higher Education within the UK is attracting a higher proportion of previously under represented people with cognitive disabilities such as Autistic spectrum disorders (ASD) or Asperger's syndrome (AS). Assessment schedules that enable students to demonstrate a range of sophisticated cognitive abilities are lacking (Sadler 2009), and despite the laudable shift towards developing student centred learning outcomes; the assessment task(s) have remained largely unchanged, with links between learning outcomes and that which is assessed, being almost always implicit or tenuous at best (Rust 2002).

The notion of lateral thinking and creativity may not come naturally to people ASD/AS; and if links between learning outcomes and assessments are implicit, then people with ASD/AS may not 'see' what other students glean from reading between the lines. This paper explores notions of fostering creativity through assessment amongst computing students within Higher Education, the potential solutions discussed may inform educational practice with all learners.

Keywords – Neurodiversity, Computing students, Assessment, Creativity, Theory.

I. INTRODUCTION

Neurodiversity is a term used to describe a group of "non-related, cognitive disabilities such as Dyslexia, Dyscalulia, Dyspraxia/DCD, Autistic Spectrum disorder, Aspergers Syndrome, Tourettes Syndrome and Attention Deficit Hyperactivity Disorder (ADHD)" (Dalton 2013. p72). Lane and Kelly (2012 p2) point out that since the 1990's there has been a sharp rise in diagnoses of autism, and therefore, it is reasonable to expect that more young adults with Autistic spectrum disorders (ASD) or Asperger's syndrome (AS) will access Higher Education.

Educators have been grappling with the concept of creativity for many years in order to understand the relationship between information and insight. Fasko (2001) in his useful review of education and creativity cites the work of Davis (1991) who argues that helping students to understand creativity metacognitively increases the consciousness of creativity, demystifies the concept and leads to an increase in creative products and ideas. According to Warne and McAndrew (2010) theoretical sense making is dependent upon the knowledge, skill, and experience of the tutor in being able to bring pre-conscious thoughts or implicit knowledge to the fore through Socratic questioning and so enable students "to anchor what for them, might appear to be free-floating theories to the grounded reality" of their experience and learning (p5). This paper discusses the issues associated with fostering creativity through assessments for students with ASD/AS undertaking Computing courses in Higher Education.

Computing courses are perhaps more likely to attract students from a neuro-diverse background, as discussed later in this paper It should be remembered however, that many non-neurodiverse individuals may also struggle to be creative, and therefore this paper may inform educational practice with all learners. More recently, Robinson (2006) discussed how education system is predicated on academic ability and often that the importance of this is hierarchy regarding subject matter has resulted in academic inflation which subsequently devalues education, and stigmatises creative application. Robinson argues that intelligence is diverse, we think visually, in sound and kinaesthetically, intelligence is dynamic and interactive (Robinson 2006, TED). He offers a personal definition of creativity as "the process of having original ideas that have value, promoted through the interaction of interdisciplinary ways of seeing things" (Robinson 2006, TED). According to Glen and McManus (2013) for those working in technology driven disciplines such as computing creativity requires students to work on assignments that are relevant, meaningful and make a difference; engage with problems that to others might appear insurmountable and enable them to demonstrate their mastery.

II. INCIDENCE SKILLS TRAITS

Estimates of the incidence of autism in the United Kingdom are varied, as according to some, autism affects approximately 0.6 to 1.57% of the population, with a higher prevalence amongst males (Newschaffer *et al.* 2007, Fombonne 2005); whereas in other studies, the prevalence is estimated to be 9.8 per 1000, and with rates being higher in men, those without educational qualifications and those living in rented social housing (Brugha *et al.* 2011). Individuals with conditions such as AS experience difficulties which include: impairments in non-verbal behaviour such as eye contact, a lack of social reciprocity and lack of interaction with peers (despite an often strong desire to do so), or repetitive behaviours, restricted range of interests to the exclusion of other activities, repetitive adherence to procedures and routines; with skills tending to be learned by rote (Cobb, Beardon, Eastgate, Glover, Kerr, Neale, Parsons, Benford, Hopkins, Mitchell, Reynard and Wilson 2002). Adults with AS also describe their communication difficulties as provoking anxiety and depression (Griffith *et al.* 2011). Griffith *et al.* (2011) conducted an interpretive phenomenological study with ten individuals in middle age to reveal the duality of limitation and freedom associated with living with AS. The respondents articulated that obtaining and retaining

employment is difficult due to unpredictable mood swings and struggles with social interaction. Employability of students on graduation is a key driver for many institutions.

Lyons and Fitzgerald (2013) highlight the classical portrait of someone with autism as having stereotypical behaviours with a preference for sameness and routine resulting in a lack of imagination. They go on to suggest that creativity and imaginative thought is often portrayed as extremely difficult or even impossible for individuals with ASD, but point out that certain features of ASD foster creativity; these include "narrow interests, great persistence, ability to see details within a whole, a fascination with facts (rather than people) and having savant type talents. While social imagination is impaired, autistic imagination of the Einsteinian type is amplified" (Lyons and Fitzgerald 2013. p772). It is perhaps not surprising then that students undertaking computing courses in Higher Education may have a higher proportion of individuals with ASD / AS. Many of whom will struggle to be creative in their assignments. According to Glen and McManus (2013), the issue is one of crafting powerful problem statements which truly engage those with a technical mind, enabling them to plan forward in time; in short educators need to use the right tactics to motivate students to be creative.

III. HOW THE MIND WORKS

Grandin (2009) in her insightful paper identifies three specialized autistic/ Asperger cognitive types: visual thinkers, pattern thinkers and verbal specialists. Grandin provides a detailed description of how (as someone with autism) she thinks like an Internet search engine using photo-realistic pictures in a bottom-up approach to find multiple fragments of details which she then assembles together. According to Grandin, visual thinkers are often poor at algebra because unlike geometry and trigonometry; this cannot be visualised. Pattern thinkers use sophisticated patterns instead of photo-realistic pictures to see patterns and relationships particularly between numbers or musical notes. Finally, verbal specialists are word-fact thinkers having a vast memory bank for verbal facts; but these people are often poor at drawing and other visual thinking skills (Grandin 2009). Keeping Grandin's description of 'thinking like an internet search engine' in mind; in terms of computing; the search engine itself is not creative: rather it is responsive to the person inputting the search terms. Therefore, when setting assignments that require students to be creative, Grandin suggests using several key words that students with ASD/AS can latch on to in order to foster such creativity.
De Bono (1990) states that

"It is convenient to talk of the mind as if it were some information handling machine as perhaps like a computer. The mind is not a machine, however, but a special environment which allows information to organize itself into patterns. This self-organizing, self-maximizing, memory system is very good at creating patterns and that is the effectiveness of mind" (p7).

Later he states "the mind however does not actively sort out information. The information sorts itself out and organizes itself into patterns. The mind is passive" (p20). This pattern making system outlined by de Bono would seem to concur with the pattern thinkers identified by Grandin. De Bono suggests that creativity is linked to lateral thinking and that lateral thinking can be fostered through practice and re-examining what is already known in different ways in order to generate alternative approaches or solutions. For de Bono lateral thinking and creativity means learning be be comfortable with being wrong, or making poor choices in terms of the processes undertaken. Warne and McAndrew (2010) describe this as enabling students to explore the complexities, difficulties, challenges and rewards for working and learning in the place between '*knowledge*' and '*knowing*', the place of '*not knowing*'. Warne and McAndrew (2010) advocate that many traditional approaches to higher education stifle creativity and suggest that theoretical sense making is dependent upon the knowledge, skills and experience of the tutor. Instead, Warne and McAndrew offer innovative approaches such as using painting to develop self-awareness and reflection whereby teachers relinquish attempts to control (and to a certain extent manage) the learning process, but where students can demonstrate self-determined learning (Warne and McAndrew 2010). Warne and McAndrew are talking specifically about enabling healthcare students and it remains unclear whether such approaches might be useful with computing students, particularly the neuro-diverse.

IV. FOSTERING CREATIVITY IN ASSESSMENTS

Educators are legally and morally required to make reasonable adjustments for disabled learners (Lane and Kelly 2012), however students are also responsible for notifying the provider of their disability. Roberts and Mitchell (2005) discuss how in practice students are not always keen to share their diagnoses with their peers and suggest that educators have an important role in supporting students in disclosing their learning differences with the group, so that the group can learn together in a mutually supportive manner.

Sadler (2009) advocates that students themselves should engage in making multiple holistic judgments of complex works, using the work of their peers and an anonymised teacher response to the same task. Here Sadler is referring specifically to enabling students to identify what constitutes quality work by having experience of its application without being bound by tightly specified criteria. This, he suggests mirrors the way in which experienced teachers make judgements. The same might be true of encouraging students to recognise creativity. It may be possible to engage students in peer review in order to foster vicarious learning whereby those individuals with ASD/AS may be immersed in an environment where they can focus on recognising elements of creativity and repeat these within their own pieces of work. Rizzo, Schutt and Linegar (2012) describe the creation of The Lab, a technology enabled learning community of young people

with AS and High-Functioning Autism (HFA) in Australia whereby participants undertake mentored programming, 3D, design and gaming activities within a social context. The work employs activity theory and the zone of proximal development to create a socially situated learning community where young people with AS/HFA solve problems and learn concepts and skills that they would not learn if not assisted by skilled peers and mentors. Rizzo *et al.* (2012) go on to explain that it is not only the people that assist the students to move beyond their perceived level of ability; overlapping technological tools to which students are exposed is also important as the teachers adopt a staged approach to programming lessons. Cobb *et al.* (2002) also advocate a staged approach to learning in creating a virtual café for students. The aim of the Café is to enable students to learn and rehearse social skills in a safe environment: a realistic 3D environment where individuals can interact and explore in real time. Users decide on their actions from three pre-defined responses to the given social situation. Cobb *et al.* (2002) argue that the benefit of this approach is that the educators can control the parameters within the environment (number of people, chairs, tables) which act as cues; and the number of solutions to a given problem. This flexibility enabled Cobb *et al.* to devise scenarios with sequential scaffolded learning at three different levels dependent on the difficulty of the social interaction task required of the user. However, it is unclear from these two studies whether the staged approach fosters or stifles creativity. In particular, by limiting the responses that students can choose, Cobb *et al.* (2002) may actually be stifling creativity.

Other authors advocate the use of teaching techniques to stimulate both convergent and divergent thinking as a means of fostering creativity such as problem or enquiry based learning (Rizzo *et al.* 2012. Roberts and Ousey 2004). Problem based approaches enable the group to generate learning goals, and agree on a way forward in order to meet those goals; students may decide to work individually or in smaller groups to retrieve information. Students with ASD/AS may find it difficult to participate in the rapid discussion associated with problem based learning, and this may result in those students returning with what might appear to be irrelevant material (based on what they thought was discussed, or their personal interest) (Roberts and Mitchell 2005). Skilled group facilitation by the teacher, can however help to achieve the balance between 'letting the students go', thus fostering creativity and ensuring that they meet the learning outcomes (Roberts and Ousey 2004). When using PBL with students with ASD/AS they should assume the role of the computer programmer, since this is the role to which they aspire and will enable them to control the direction of their learning and creativity. Assessments based on problem solving and problem finding are also suggested as mechanisms to foster creativity; particularly when students work in group activities. Group activities are thought to provide additional opportunities not only for students to enhance their creative thinking, but also to develop peer acceptance (Roberts and Mitchell 2005). In using new approaches to learning some students (particularly those

with ASD/AS) experience inner conflict as their pre-constituted beliefs are often highly resistant to change and they will cling on to the familiar in order to achieve ontological security. Threshold concepts can give rise to troublesome knowledge, primarily because they are alien and at times counter-intuitive requiring the student to enter the world of the unfamiliar; resulting in a degree of student resistance (Warne and McAndrew 2010). For some, provoking thought is an essential attribute in university education, but one that has been killed by intellectual vitality and creativity being increasingly stultified (Evans, 2004; Robinson 2006, Morrall, 2010, Warne and McAndrew 2010).

Rust (2000, 2002) calls for some form of continuous assessment with "plenty of formative feedback at regular intervals" (2002. p149). In doing so he is of the opinion that assessment will be seen as having relevance and importance beyond the assessment itself, and thus discourages students from adopting a surface approach to learning (Rust, 2002). This approach may be particularly useful for students with ASD/AS, since they can rehearse and refine the assessment many times prior to final submission. He goes on to call for systems to be created which fosters the students being directly responsible for tracking and recording their own learning, and whereby students are enabled to use a variety of sources of evidence to support their claims to meeting the learning outcomes for the programme such as taught modules, work based learning, resource based packages, distance learning packages, formative feedback by tutors, peers and themselves, or work experience. Rust argues that such an approach acknowledges the work that takes place beyond the formal curriculum. The student becomes a partner and an active participant in their own assessment and has a greater stake in devising their own curriculum (Rust, 2000). Lane and Kelly (2012) explain that students with ASD/AS may not necessarily understand the need to give more information than is directly requested by a question and hence will tend towards literal interpretation of requirements. Lane and Kelly (2012) suggest that in order to overcome this, student's benefit from having a number of specific questions in order to encourage the ordering of thoughts and focus attention on one issue at a time, and in so doing fits with a more local rather than a global aspect to data processing. It is interesting to note that Lane and Kelly use terms such as data processing; which would seem to support Grandin's notion of people with ASD/AS having a mind that works like an internet search engine.

V. CONCLUSION

Within Higher Education more young adults with diagnoses of autistic spectrum disorder and or Asperger's syndrome are evident, with the incidence being higher in men than women. It is perhaps not surprising that computing students with ASD/AS may find being creative in assignments very difficult. Educators should therefore consider using teaching strategies such as problem based learning with computing students assuming the role of computer programmer; having staged approaches to

programming sessions and encourage students to work collaboratively in teams and innovative approaches such as painting. Educators should also consider the role of assessment in fostering creativity and develop assignments with specific milestones or key words for students to focus on. In addition, students should be given opportunities for repeated formative assessment and regular feedback. There are expectations that students will be able to demonstrate lateral thinking and creativity within their assignments; something which some students (particularly those who are neuro-diverse) may struggle to do; therefore the emphasis is on educators to understand the impact of ASD/AS on undertaking assessments and provide students with opportunities to demonstrate their knowledge, skills and understanding. Many non-neurodiverse individuals may also struggle to be creative, and therefore the potential solutions discussed within this paper may inform educational practice with all learners.

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