Presenting science to young adults with intellectual disabilities: The Steps of Thinking

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Introduction

The fields of science and science communication have long neglected students with intellectual disabilities. Increasingly, attempts have been made to include students with some disabilities in science activities, shows and exhibitions. However, when it comes to intellectual disabilities, it has been a case of too little for too long. Recent research reveals that science (like other academic activities) has been withheld from students with intellectual disabilities for over 40 years in most Western countries, with the exception of some token activities (Culham & Nind, 2003; Yates, Dyson, & Hiles, 2008). To counteract this, and to test whether science activities could be of benefit to students with intellectual disabilities, I developed multiple science programs, and conducted a series of case studies to investigate the short term and long term effects on high school students with moderate intellectual disabilities (that is, students aged between 12 and 18, who combine social and practical impairments with a tested IQ approximating between 40 and 70). The results were unanimously positive, with all students showing improvements in both their academic and daily lives. This paper outlines the method I developed to enable the students to achieve these results: The Steps of Thinking for People with Intellectual Disabilities.

Disability and Science

The language around disability is constantly changing, so before I begin some clarifications are necessary. In this paper, the terms ‘disability’ and ‘ID’ refer to intellectual disability. ‘Neuro-typical’ refers to not displaying the characteristics of intellectual disability. The word ‘parents’ refers to both parents and other legal guardians. All terminology is in keeping with current practices and is used with due respect.

Science and science communication usually claim to be moving toward greater inclusion with respect to gender, culture and other diversity sensitivities. However, when it comes to intellectual disabilities, we are still struggling, even though people with ID make up a growing segment of our public. The literature in this area shows that science has been systematically withheld from students with ID for over 40 years (Culham & Nind, 2003; Flynn & Lemay, 1999). There are some schools and informal centers that attempt to offer

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science to students with ID. However, current research reveals that these activities are having minimal and sometimes even negative effects (Australian Senate Standing Committee, 2016; Kucharczyk et al., 2015).

The rationale for continuing to withhold science from students with ID is twofold: First is the notion that science activities do not assist in the daily life skills that students with ID urgently need. Second is the dual idea that science is too complex for students with ID, and that ID is too complex for a systematic method of science delivery (Cocks, 2001; Kucharczyk et al., 2015).

In contrast, I hypothesized that ongoing science delivery could exercise the observational, rational and logical skills that students with intellectual disabilities find most difficult, and thereby assist in their life skills.

To test this, in this research project I developed multiple science activities, which I delivered to high school students (aged 12-18) diagnosed with moderate intellectual disabilities. That is, students with a tested IQ approximating 40>70, together with at least some of the following characteristics: extreme difficulty demonstrating reasoning, problem solving and abstract thinking; difficulty in social situations including difficulty with personal hygiene, communication and practical daily activities; difficulty in understanding one's own feelings and those of others; and difficulty acting in a way that does not harm oneself or others (Weis, 2014). These were my participants and they took part in my activities under the supervision of a teacher they were familiar with. The activities ranged in complexity from identifying colors, to mixing substances such as bicarbonate soda and vinegar to make basic chemical reactions, to building propellers and rockets.

I then collected data regarding the impact of my science activities on the students' daily life skills. The data took the form of interviews with the students, their parents and their teachers at multiple intervals, over a time-frame of one year (74 total participants). The results were unanimously positive. All students were reported to have shown a noticeable and lasting improvement in their daily, personal and social skills. All students were also reported to have shown noticeable and lasting improvement in their academic lives, particularly in their observational and rational skills.

Method: The Steps of Thinking

This paper focuses on my systematic method for enabling students with intellectual disabilities to achieve these results. My method involves intricately guiding students through the step-by-step process of observation, logical enquiry and rational response.

OBSERVATION: I gave students the catch phrase, "Look, Look, Look; Listen, Listen, Listen; Think, Think, Think". This may seem quite a basic start. However, for the past 40 years the primary mode of disability education has been a form of compliance training. Such training involves students being drilled through prompts (Fields, 2013; Goldiamond, 2002). The prompts direct students to say or do the 'right thing', when their own intellect might not be able to produce the desired response independently. This is sometimes known as 'errorless learning' (Brown, Peace, & Parson, 2009; Jones & Eayrs, 1992; Mosk & Bucher, 1984). So what has happened? Generations of students with ID, for the past 40 years, have been drilled into using someone else's prompts rather than their own senses for thinking. For students with ID, the first of *my* Steps of Thinking is, "Tell me what your own eyes see", "Tell me what sound you heard", and so on.

LOGICAL ENQUIRY: The next Step is getting the students to interrogate their observations using 'what', 'when', and 'where' questions. What exactly did you see? What size, shape, color, quantity? When did you see it? When did you hear something? Where did you see/hear it? Where is the noise louder?

RATIONAL RESPONSE: By this I mean a reasoning response in which the students continue to think about the phenomenon they have observed and try to build a greater understanding of it. I ask the students a further question related to their original observation. They must first guess the answer and then test it. This 'guess and test' process is nothing new. It is a basic form of scientific experimentation through which the students proceed through failure. By eliminating wrong ideas themselves, the students were able to predict answers more accurately, and grew stronger in their understanding of their original observations. Now rather than depending on external prompts to be guided into an answer/behavior that someone else desires, the student can test things for herself. And by ongoing testing, she gains a greater understanding of what is a more acceptable, accurate and/or appropriate response.

Examples

Here is an example that compares current compliance training to my Steps of Thinking. It was an example that recurred several times during my activities with multiple students. My most basic activity involved identifying colors. I poured water into test-tubes and added red food color into one.

I would then ask the students, "What color is this?"

The typical answer was, "I don't know", or silence.

The supervising teacher would prompt, "rrrrr".

The students would say, "rrrrr".

The teacher would prompt, "rhymes with dead".

The students would say, "I don't know", or stay silent.

The teacher would say, "rrrrr and dead…rrrrr and dead".

The students would say, “I don’t know”, or remain silent.

The teacher would say, “I think it’s ‘RED’”.

The students would say, “red”.

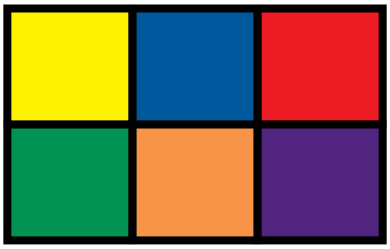
The literature agrees that this is a typical and useful way of using prompts and errorless learning for students with intellectual disabilities (Fields, 2013; Wong et al., 2015). The answer desired by the teacher is said by the student. Indeed, the student cannot help but give the response desired by the teacher. However, in my view, the student has not communicated an understanding of ‘red’, or even an understanding of ‘color’.

Here is the alternative, using the Steps of Thinking.

I again ask students, “What color is this?”

The students typically answer, “I don’t know”.

I produce a color chart, as seen below.



I ask, “Tell me what your eyes see”.

The students typically reply, “Colors”.

I then ask, “Do you see the test tubes?”

The students typically reply, “Yes”.

I ask, “Do you see the colored test tube?”

The students typically reply, “Yes”.

I then ask them to point to the colored test tube.

I ask them to point to *that* color on the chart.

I say, “That color is called red”. Then I ask them to point to everything in the room that they think is red. If the students point to something that is not red, I redirect them to the color chart and ask, “What do your eyes say? Is that other thing red or not?”

At this stage we have already moved into logical enquiry: What is red? Where is red? And some students could even move into discussing *when* something stopped being red and started becoming something else; for example, pink.

I then move on to 'guess and test': the students' ongoing reasoning response. I ask the students to guess what we would make if we mixed blue and red. Again, the typical answer is "I don't know". I reply, "Yes, a guess is what you do when you don't know yet; so guess". We then mix the colors to test whether the guess was accurate. If the students were right we cheer and go onto another mix. It the test shows that the guess was wrong, I get the students to cross out the wrong guess on the color chart and then guess again from the remaining possibilities.

In this manner, the student participants were carefully guided through the Steps of Thinking which most neuro-typical people do automatically. This was the most basic activity**.** I then repeated my Steps of Thinking through increasingly complex activities. More complex activities required increased guidance. However, the need for guidance plateaued as the students' skill also increased. The individual differences between students meant that their individual skills improved at different rates and to different extents.

Conclusion

Finally, I encouraged students, parents and teachers to use the Steps of Thinking in daily activities. For example, in conversations, students used 'Look, Listen and Think' to focus on what was said and in what context. The 'enquiry questions' were then used to further clarify. Ongoing rational/reasoning responses became their attempt at conversation – they need no longer give one-word responses or 'I don't know'. Rather, they could now engage in a genuine dialogue to pursue understanding.

As mentioned, results were unanimously positive. Regardless of individual differences between students, lasting improvements were reported for all, including greater independence in life skills and greater ability to generalize particular learning into broader contexts. All student participants went on to further adult education or part-time work and some are now doing both.

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