Developing a Mathematics Module for Students with Intellectual Disability in Higher Education

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Abstract

Students with intellectual disability (ID) have to overcome many barriers and difficulties in order to access all levels of education and partake in college life. Thankfully, educational institutes around the globe are slowly beginning to examine how they can support equal rights of individuals with ID. In Ireland, one university has recently accredited an innovative higher education programme for college students with intellectual disabilities. One of the emergent modules focuses on mathematics and realises the important role that numeracy plays in today's society. Despite the increased emphasis on general mathematics education, the authors found there to be a dearth of research regarding the development of such a module for students with ID. This paper describes the design and development of the mathematics module and also details its piloting and evaluation with a cohort of students with ID who were enrolled in a higher education course in an Irish university.

Keywords: Students with intellectual disability, Mathematics education, Higher education, Course development.

1. Introduction

The aim of this paper is to highlioght the design, piloting and evaluation of a mathematics module for students with intellectual disability (ID) as part of a higher education programme. The authors felt it was important to share this process given the sparse research available on curricula design, and more specifically mathematics curricula design, for students with ID (Göransson et al., 2016). Shurr and Bouck (2013) carried out a systematic review of research on curricula for students with ID by analysing articles from ten key journals between 1996 and 2010. Their results showed that articles on curricula for students with ID represented only 2% of the articles published during that time and there was a 19% reduction in such articles over the period. Restricting the field to mathematics, a recent review of the literature by Hord and Bouck (2012) between 1999 and 2012 resulted in only seven articles on curricula for students with ID. Consequently, very little is known about developing mathematics curricula for students with ID. Considering the overwhelming interest in and amount of research about mathematics education for other groups of students, the authors felt it was important to develop the same research based guidelines to help teachers improve their teaching of students with ID.

With this in mind, this paper describes the design, piloting and evaluation of a mathematics module for students with ID who were enrolled in a higher education course in an Irish university. The research was divided into three main phases. Firstly, a review of existing literature on developing mathematics curricula for students with ID was conducted. The findings guided the design and development of the module. Once the module was developed it was piloted and evaluated with a group of students with ID.

2. Review of Literature

2.1 Overview of the Issue

Having an intellectual disability is often associated with stigma and discrimination (Jeevanandam, 2009). People with ID are one of the most socially excluded groups and encounter prejudice and significant barriers that restrict their ability to access human rights (European Union Monitoring and Advocacy Programme report, 2005; Spassiani & Freidman, 2014). Despite being considered the leading socio-economic health care problem in developed countries (Salvador-Carulla & Bertelli, 2008), members of the public frequently show a limited understanding of ID (Gordon, Feldman, Tantillo, & Perrone, 2004; Mencap, 2008). Individuals with ID are often viewed as nonhuman and as the outsiders of society (Goodley, 2001; Carlson, 2010; Milner & Kelly, 2009; Spassiani & Friedman, 2014). For example, Scior (2011) found that individuals without a disability want greater social distance from people with

ID than from those with physical disabilities.

This prejudice and limited public knowledge are set against a background of limited available resources for individuals with ID (World Health Organisation (WHO), 2007). Maulik et al. (2011) determine that there must be more importance on developing infrastructure that support people with ID. Attention should be focused on improving their integration into education, work and social settings (Maulik et al., 2011). At the moment there is a limited number of opportunities available to people with ID (Wehmeyer & Bolding, 1999), and this includes access to higher level education. Policies governing services for people with ID must aim to maximise their social inclusion, independence and empowerment (WHO, 2007). At a national and international level, governments need to be more active in overcoming the barriers to inclusion through improving access to mainstream services, and devising and investing in disability strategies (Ali et al., 2012).

Perhaps one of the most important strategies in reducing the barriers is to improve the transition of young adults with disability to post-school life (Flexer, Simmons, Luft, & Baer, 2005). Options for this student population at this key transition stage are generally intricate and uncommon (Davies & Beamish, 2009). For the last twenty years, small-scale studies in the U.S. (Keogh, Bernheimer, & Guthrie, 2004), Australia (Murray, 2007) and the U.K. (Smart, 2004) have produced negative findings related to both the transition process and post-school life for young adults with disabilities and their families. These studies provide evidence that young adults with ID have poorer post-school outcomes and are at risk of experiencing a poorer quality of life compared to their peers (Davies & Beamish, 2009). This highlights the importance for these young adults to develop skills and independence which need to be provided through continuing educational opportunities.

2.2 Educational Opportunities for Students with ID

The education of students with disabilities has undergone several shifts in the past few decades. For example, in the 1970's there was a policy of "normalisation" (Göransson, Hellblom-Thibblin & Axdorph, 2016). The education of students with disabilities focused on training basic skills in self-care, socialisation, and recreation. However in recent times, inclusion has become "a global agenda" (Pijl, Meijer, & Hegarty, 1997) and education policies have been increasingly changing towards this model in many countries (Dessemontet, Bless & Morin, 2012). However there are a lot of varieties in the way that inclusive education is implemented across different nations (Ferguson, 2008). Ferguson's study determines that while some countries have developed broad inclusive practices, others still educate individuals with ID in special classes or special schools. This may appear to be conflicting with the notion of inclusion, given that one of its aims is to make education accessible and equal to students with disabilities (Göransson et al., 2016). However, there is evidence that different educational settings may expose individuals to different levels of stigmatised treatment (Cooney et al., 2006). A study conducted by Szivos-Bach (1993) found that young people with ID who are educated in integrated schooling often believe that their social identity is devalued. Those educated in segregated settings may be protected from an insight into the devalued status that people with ID can hold in society (Todd, 2000). On the other hand, studies have shown that inclusion allows students with ID to make similar, or more, progress in their academic achievement and adaptive behaviour than separate educational settings (Dessremontet et al., 2012).

Irrespective of integrated or segregated schooling, opportunities for students with ID to participate more fully in the core curriculum have greatly increased over the past two decades (Burton et al., 2013). Burton et al.'s study found that there is a greater focus on individual strengths and fostering independence in the presence of high expectations for students with disabilities. However despite these improvements, some international research on students with ID has criticised their schooling for focusing too much on care, and not enough on challenging students academically, particularly in the subject of mathematics (Göransson et al., 2016).

2.3 Mathematics Education for Students with ID

Large scale national achievement testing in the U.S. indicates that the majority of students with disabilities do not reach grade level proficiency in mathematics (U.S. Department of Education, 2009). For students with ID, this situation becomes even more worrying since they may have limitations that lead to difficulties with the learning of certain mathematical concepts (de Oliveira Malaquias et al., 2013). For example, students with ID are likely to experience difficulties with problem solving and abstract reasoning (e.g. drawing conclusions, making generalisations, representing concepts symbolically, etc.), which are fundamental to the learning of mathematics (Hord & Xin, 2015). They may also have difficulty with spatial relationships, distances, and sequencing which can interfere with the acquisition of mathematics concepts and skills, such as estimating size and distance and problem solving (de Oliveira Malaquias et al., 2013). There are often struggles with remembering information that was presented which leads to confusion with the abstract symbols used in mathematics (e.g., minus, greater than, less

than, etc.). Furthermore, some students with ID struggle with motivation to learn mathematics and often require the mediation of the teacher to get involved with activities (de Oliveira Malaquias et al., 2013). This is especially true of more difficult and abstract activities in the subject that do not have an immediate and clear social function.

Despite these typical features, in some research studies students with ID have succeeded in challenging areas of mathematics such as making sound mathematical decisions to solve word problems and creating their own strategies for solving arithmetic problems (Hord & Xin, 2015). A study carried out by Westwood (2011) evidenced that if students with ID are engaged, and their educational needs are supported through the use of effective resources, then they can experience success in their academic endeavors.

2.4 Mathematics Curricula Development for Students with ID

Since the middle of the 20th century, there have been significant on-going shifts in the structure, content, and core principles of mathematics curricula in countries around the world (Schoenfeld, 2014). Recent changes such as the widespread adoption of the Common Core State Standards in Mathematics in the U.S. and Project Maths in Ireland, both in 2010, indicate that there is return to a focus on problem solving and placing mathematics in context so that students can make sense of what they are learning (Schoenfeld, 2014). This shift in perspective requires a different style of teaching, in which students' own participation in the learning process is emphasized (Griffin et al., 2013). This is often formulated in terms of a shift from a procedural to a conceptual approach to teaching and learning mathematics. However, research indicates that the tradition of mathematics instruction for students with ID continues to focus on the practice of direct instruction which leaves very little room for the student´s own initiative and participation (Göransson et al., 2016). Teachers typically focus on repetitive practice of computational skills, based on the belief that students must master readiness skills before engaging in higher order mathematics lessons (Browder et al., 2012). One implication of this is that students with ID and particularly those who attend segregated education seem to have less access to curricula that promote a deeper conceptual understanding of mathematics (Göransson et al., 2016).

As mentioned previously, very little is known about developing mathematics curricula for students with ID. What is known is that students with ID comprise a very diverse group and each student has specific educational needs (Rhodes et al., 2015). Their cognitive and adaptive limitations vary from person to person and as a population, they are characterised by a variety of strengths and weaknesses in broad abilities (Bergeron & Floyd, 2006). For this reason, it is not possible to either draw a typical profile of people with ID or specify standard features of their personality or behaviour (Westwood, 2011). However the following generalised points were noted in a range of different studies in the literature about important aspects to consider when teaching mathematics to students with ID.

- Step away from the textbook: Textbooks on educating students with ID provide minimal information on teaching mathematics besides in traditional topics such as money and measurement (Snell & Brown, 2006). These content areas are only a small sample of the recommended content for mathematics (Browder et al., 2012).
- Educational games are a resource that can be used as an alternative to textbooks and other traditional resources and can promote inclusion, regardless of students differences (de Oliveira Malaquias et al., 2013)
- Visual representations are likely to help students with general disabilities (Kroesbergen & Van Luit, 2003). For example the use of manipulatives, either concrete or visualised, are useful aids for students to solve mathematics problems. They are especially useful for solving addition and subtraction problems (Jansen et al., 2013).
- Technology can also increase opportunities for students with ID to access the core curriculum and achieve improved learning outcomes (Burton et al., 2013).
- Students with ID are in need of instruction incorporating a blend of academic and functional mathematics objectives (Burton et al., 2013). Functional mathematics focuses on teaching practical mathematics within real-life situations.
- Skill development may be promoted by linking mathematics and language (Zambo, 2005), specifically problems that are written within a context familiar to the student. However, since students with moderate and severe ID may not read, teachers may need to ensure an interactive read-aloud (Browder et al. 2012).
- With this is mind, attention must be given to the linguistic demands of mathematics assessments. Though tests of mathematics may routinely employ word problems, the use of language-formatted items may adversely affect students with ID. It is possible that student limitations in language ability may overwhelm

their performance on what is desired to be a test of mathematics (Rhodes et al., 2015). Thus the use of multiple choice is recommended for assessment (Zikl et al., 2015).

2.5 Design and Development of Mathematics Module for Students with ID

Many of the points noted in review of literature in the previous section were taken into account for the design and development of a mathematics module in a recently accredited higher education programme for college students with ID. The module comprises of eleven, two hour lectures over the course of an academic semester in an Irish university. The module has four main aims:

1. To develop in students the ability to think critically about mathematics, express viewpoints, discuss logically and problem solve effectively.
2. To equip students with the mathematical skills that they may require on a daily basis.
3. To inspire students to develop their own mathematics learning skills which they may need to confidently navigate today's society.
4. To encourage collaborative learning through project-based tasks incorporating mathematical skills and practical application.

The content is a mixture of mathematical theory and practice and includes traditional topics such as money and measurement. However, as recommended by Browder et al. (2012) the module also includes other content areas such as statistics and probability and trigonometry. There is an emphasis on teaching all topic areas within practical, real-life situations (Burton et al., 2013). For example, students have to use their computers to plan holidays to various destinations and calculate their exact travel, accommodation and spending money budgets. These practical tasks are combined with improving students' mathematical literacy. For example, students have to work out their average spend per day on each holiday and the range of money that they spend per day. The majority of these tasks are impossible without the automation of basic mathematical skills (i.e. addition, subtraction, multiplication, and division). However research shows that students with mild to moderate ID (IQ score 55–85) often complete their schooling without mastering these essential basic skills (Butler et al., 2001). It was decided that there was not enough time to teach these skills competently on this module in twenty two hours of contact time. Hence it was decided to ensure that students were proficient with the use of calculators, both on their phones and using the Internet.

The teaching approaches are a mixture of problem-solving and practical workshops that incorporate teamwork, collaborative learning and whole class input and discussion. This offers students a flexible approach to learning with a special emphasis on peer teaching which is important given the range of abilities of students with ID. Resources such as educational games and the use of manipulatives are regularly employed as an aid to students learning and to foster inclusion and motivation.

In terms of assessment, formative assessment takes place regularly during the course with regular practical homework assignments and with students invited to share ideas and discuss and debate views in each lecture. The use of regular questioning and the observation of student performance on in-class tasks enables the constant monitoring of performance and regular feedback. The summative assessment includes an end-of-term examination which is comprised mainly of multiple choice questions.

3. Method

Once the module was developed it was piloted and evaluated in the 2015/ 16 academic year with a group of students with ID who were enrolled in a higher education programme. There were twelve students in total in the class with a range of mild to moderate ID. The students were taught the module over an eleven week period. Ethical approval was sought and received from the University's Research Ethics Committee, and at the end of the semester two focus groups were held with consenting students in which the module was evaluated and advice was sought on how the module should be run in future. This ensured that the students had the opportunity to be involved in the future design and implementation of the new module which is particularly important for students with ID. Grant and Ramcharan (2001) recommend that disability research has "a continued emphasis on establishing user views and experiences through small-scale studies" so that these views and experiences "can act as a driving force for change" (p. 358).

The focus groups which were made up of eight students in total (five in the first group and three in the second) were conducted by one of the authors who was not involved in the delivery of the course. They were approximately fifty minutes in duration each. The focus groups were digitally recorded and subsequently transcribed verbatim. Participants were identified by a letter and a number, for example S1 (Student 1) and all personal names and identifiers were removed from each transcript.

The focus group data was analysed using a thematic content analysis. Although this study did not involve a large amount of qualitative data, it was decided that two of the authors would carry out the analysis to increase comprehensibility and to provide sound interpretation of the data. A coding scheme was generated based on the main themes which were identified from the transcripts. Each of the authors worked separately on the transcripts, which made the assessment of consistency between their coding mandatory. The coding of each transcript was compared consecutively and any discrepancies were discussed. The final coding scheme consisted of three major codes namely module content and design, student feedback, and transfer of knowledge to facilitate independence. Each of these themes will be discussed in more detail in the next section.

4. Results and Analysis

4.1 Module Content and Design

The students described module content and design stating that they learned topics such as adding, subtracting, dividing, multiplying, budgeting, prime numbers, odd and even numbers, trigonometry, average, mean, and range. The module consisted of assignments and a test that each student was required to complete. S1 stated that "*The maths module has been really good so far. We learned about evaluations, numbers, dividing, multiplying. We did exams. We learned how to use our calculators on our phone.*" For most of the students this was the first time they had been introduced to such content. S6: "*Math class is very good because you get to learn a lot of stuff that you haven't learned before like adding (...) more subtraction and more multiplying. You actually get to do a lot more than you ever had done before and you don't know how good you are at it until you actually go into a math class and ID course*."

Within both focus groups students described the teaching strategies and resources used in the mathematics module that they found to be effective in learning module content. They discussed how using technology during mathematics lectures made it easier to understand concepts. For example, the students spoke about how the instructor would sometimes use the computer to teach the mathematics lesson and ask the students to complete their mathematics exercise on the computer as well. S5 said "*If you have an A4 page you're gonna have to go through 100 pages or whatever. So, I think it's easier that way*." S6 described their views on using a computer in mathematics class as a recourse tool *"[The instructor] shows us how to use a calculator from the computer. It's a miracle 'cause that's the first time I actually found out there actually was a calculator on the computer".* Other students talked about how the mathematics module taught them how to use the calculator on their smart phones which they found to be helpful in completing assignments. Many of the students spoke about how the use of manipulatives such as Izak9 cubes (www.izak9.com) were helpful when learning about prime numbers as S6 stated "*It helps us count up the numbers."* While other students spoke about how working in small groups was also helpful in learning module content.

Students described instructor feedback and support as playing an important role in understanding concepts. Students were not afraid to ask the instructor for help or clarification. The instructor would go over the test and assignments with students to make sure they understood how to do questions properly. S5 stated "*Because he was like this is how you do this one. But at least you tried and this is how you do it correctly*".

4.2 Student Feedback

Overall the students had positive feedback about the mathematics module. S1 student stated "*It's a really good class, it's really interesting. You learn new things every wee*k." They spoke about how they enjoyed the class and learning new things that they previously did not have the opportunity to learn. S6 explained *"Yeah, it definitely helps me get through the harder stuff now than any regular course had ever did. I went to a load of courses before. They didn't really help me as much as this course does. And this course has helped me get the harder stuff done easier and find out an easier way around it."* Students spoke about how they now have a better understanding of how to perform mathematical operations such as adding, subtracting, dividing, and multiplying. S7 stated "*I like the math class because it helps me with getting the money sorted. I have difficulty with the money. And it helped me with money because I work with money*". S1 stated "*I found it interesting as well because I felt I was learning something new that I haven't learned before*."

Many of the students talked about how the mathematics module they took at university was very different from any other mathematics course they had previously taken in school. Students talked about how they did not learn about many of the content areas they were taught in their college mathematics module. They spoke about how they hardly received tests and how no one ever received mathematics assignments in school. The students felt as though they were not being challenged in their learning like they were in their college mathematics module. S7 stated "*Yeah, because in school, I didn't do as much as I did here in college. And I didn't have assignments. I didn't do math for my*

junior certificate". S6 explained how they did not feel as though they were being challenged in school when learning about mathematics: "*To me it was different because in school and places like that, they don't really give you hard things, they don't really give you things to push you to the limit. In college, they give you hard things and things that push you to the limit, which is good (...) I didn't really like the math tests in school because they're far too easy for me because every time I did a math test, I always got something right and I always got to think to myself is this too easy for me".*

Students found the level of difficulty of course content to be appropriate and recommended that module content not be made more challenging for incoming students. Students described how they felt learning about budgeting, trigonometry, mean, average, and range were challenging concepts to understand, particularly for those students being introduced to these content areas for the first time. Although this information was challenging for students they spoke about how assignments helped to reinforce content. S8 said *"I think it's good to have assignments. It's important to challenge yourself to get better after doing the assignments".* S7 stated *"It [the assignments] also helped me – it was also challenging for me and it made me also concentrate even more."* The students particularly found their budgeting assignment challenging. More specifically, students described how they were given a '*pretend'* budget and were asked to plan a '*pretend'* holiday where they were required to go on the internet to find hotel and flight prices and include this in a budget they were given ensuring that they did not over spend. S7 said *"I have to go and search it in Google. And no, I mean it kind of got hard for me, yeah it kind of got a bit hard… the different types of flights and where they want to go on holiday and how much the flights were...."* Although students spoke about the budgeting assignment being challenging they also discussed how they enjoyed the assignment and found it to be a useful exercise to learn how to manage their own money or plan a holiday in the future. As S1 explained "*I also learned how much money to save up. Like if I'm going on holidays or you need money for something, you have to save up something. So, always got to have money saved up for anything that I have to do."*

4.3 Transfer of Knowledge to Facilitate Independence

The students spoke about how the knowledge they learned in their mathematics module can be easily translated to real world settings, such as for employment, community living, and becoming more independent. For example, S7 stated *"I would use it. I think it will help me when I go into shops, say for example, I don't have to ask them all the time to help me. I can do it myself. And yeah, I think it will help me with that."* S8 mentioned "*Yeah. I'll be using [what I learned] when I get a part-time job; I already use money a lot*" While S6 stated *"This will help me a lot because when I finish this course, I'll be going into an IT course next and I'll get a part-time job. So, that maths that I learn here I can bring it out in the open world and use it where you go. Not only in the course or in the jobs, you can use it outside jobs, (...) on the streets or in the shops. Where you go, it's always with you."* The concept of budgeting resonates with the students as they discussed why learning mathematics concepts are important for people with intellectual disabilities. As S3 described "*I agree with them three [students]. So, yeah to help them [people with intellectual disabilities] budget and then add and subtract in everyday life*". This was seen as important especially in regards to understanding how to save money as S1 mentioned "*Like if you are gonna spend some money, you need to know how much you're putting away and how much to spend*." S7 stated "*It helps the people with disabilities to work with a calculator and if they have trouble working with money. And the calculator can easily help you."* S6 spoke about how learning mathematics is important for people with disabilities to ensure they are not being taken advantage of when out in the community. The student stated "*Okay, this is important to me because if you're getting a job you need to know how to count your own wages because if you can't count your wages, your boss gives you the wrong wages, how do you know if the wage that you get is wrong or right.*" This student's response highlights the importance of adult students with intellectual disabilities learning advanced concepts in mathematics to ensure they are able to interact with their community and decrease the risk of potentially being taken advantage of due to having poor numeracy skills.

5. Conclusion

The purpose of this paper was to describe the design, pilot and evaluation a mathematics module for students with ID as part of a higher education programme. As one of the very few studies on curricula for college students with ID, the authors believe that the paper adds valuable knowledge to a basis for further development of an understanding of teaching students with ID and their transition to higher education.

For the last twenty years, many international studies have produced negative findings related to the transition process and post-school life for young adults with disabilities. It is important that these young adults are given the opportunity to continue developing the skills needed for independent living and everyday life. The role of mathematics in this cannot be overstated. Being able to make payments for groceries and to keep a budget are some

of the necessary competences for living independently. However, students with mild to moderate ID often complete their schooling without mastering essential basic skills such as addition and subtraction (Jansen et al., 2013). The scant research that is available suggests that there is an over emphasis on repetitive instruction practices and that students are not presented with enough knowledge-related challenges.

Göransson et al. (2016) determine that all students have a right to access curricula that foster the same type of knowledge, regardless of disability. All education institutes have a responsibility to ensure that this right is realised. Hence the module designed and developed by the authors' places an emphasis on developing students' conceptual understanding in a broad range of challenging mathematical topics using a variety of pedagogical approaches. The authors would like to stress that the philosophies and strategies used in the development of this curriculum have been in use in mathematics education with other groups of students for many years. However as noted by the responses of students in the focus groups, they have rarely, if ever, been applied to the teaching of mathematics to students with ID.

The piloting and evaluation of the module provides evidence that students with mild and moderate ID realise the importance of mathematics in their everyday lives and respond positively to being challenged in the subject. This module with some minor changes based on the student feedback will be rolled out with a new cohort of students in the next academic year. However further research will be carried out to continually assess the suitability of the content and the success of the teaching and learning approaches. The authors are aware that this is only the start of the work needed to tackle some of the current problems facing the continued education and mathematics education of students with ID in higher education.

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