The Self-Efficacy of students with Borderline, Mild and Moderate Intellectual Disabilities and their Achievements in Mathematics

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The relationship between the self-efficacy of 23 High School students with intellectual disability (ID) and their achievements in Mathematics was evaluated using a modified version of the self-efficacy instrument developed by Joet, Bressoux and Usher (2011). Four different number sense assessment tools were administered pre- and post- six months of instruction to measure their Mathematics achievement. Relevant data analyses were carried out with *Minitab* statistical software. While the mean self-efficacy was found to be about 65%, the correlation between self-efficacy and the mathematics achievements of students was weak.

The definition of intellectual disability (ID) and its levels of severity have undergone many revisions over the years in response to emerging research outcomes which have changed how ID is perceived. There is a shift in thinking from a deficiency model which suggests the problem resides in the individual with ID to the environment or support/needs model that focuses on what adjustments needed to be made to support people with ID. The term 'intellectual disability' (ID) (previously known as mental retardation) has been used interchangeably in the literature for 'intellectual developmental disorder' (American Psychiatric Association - APA, 2013, p.33) and 'intellectual impairment' (Wen, 1997, p. 2). One current definition describes ID as a form of disability that is "characterised by significant limitations in both intellectual functioning and in adaptive behaviour, which covers many everyday social and practical skills. This disability originates before the age of 18" (American Association on Intellectual and Developmental Disabilities - AAIDD, 2010, p. 1). Similarly, the APA (2013, p. 33) defines ID as a disorder that is characterised by: (a) deficits in intellectual functioning; (b) deficits in adaptive functioning; and (c) intellectual and adaptive deficits occurring during the developmental period.

For several decades IQ scores have been employed widely in describing the levels of severity of ID including borderline (IQ 84 to 71), mild (IQ 70 to 55), moderate (IQ 54 to 35), severe (IQ 34 to 20) and profound (IQ below 20) (Wen 1997, p. 4). This IQ-based classification is being phased out and to be replaced by needs-based severity codes. The APA (2013, pp. 33-36) has introduced needs-based severity codes that consist of mild, moderate, severe and profound ID. This categorisation is based on adaptive functioning rather than IQ scores and with functional limitations evaluated across conceptual, social and practical skills domains as detailed in the *Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition)*. The AAIDD (2010) has also introduced its own support-based severity codes of ID consisting of intermittent support, limited support, extensive support and pervasive support which are based on the intensity of support needed by the individual with ID. A summary description of these codes as provided by Reynolds, Zupanick, and Dombeck (2015, pp. 33-34) includes: (1) Intermittent support (equivalent to mild ID under APA standards) – "they may only require additional supports during times of transition, uncertainty, or stress"; (2) Limited support (equivalent to moderate ID under APA standards) – "with additional training, they can increase their conceptual skills, social skills, and practical skills. However, they can still require additional support to navigate everyday situations"; (3) Extensive support (equivalent to severe ID under APA standards)

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– "… they will usually require daily support"; and (4) Pervasive support (equivalent to profound ID under APA standards) – "daily interventions are necessary to help the individual function. Supervision is necessary to ensure their health and safety. This lifelong support applies to nearly every aspect of the individual's routine". The IQ-based classification was used in this study as that was the practice in place at the commencement of this study 3 years ago at the school where this study was conducted.

Self-efficacy has been defined as "beliefs in one's capabilities to mobilise the motivation, cognitive resources, and courses of action needed to meet given situational demands" (Gist & Mitchell, 1992, p. 184). This involves the "convictions that one can successfully carry out given academic tasks at designated levels" (Bong, 2004, p. 288). Embedded in this definition of self-efficacy is the affirmation of the importance of motivation and cognitive ability. Motivation and cognitive factors are essential ingredients of self-efficacy. Azar, Lavasania, Malahmadi and Amani (2010) have acknowledged that motivation and cognitive ability influence achievements among other factors. All around us today, there are everyday examples of mathematics impacting on our lives including shopping, using the phone, transport, money, cooking and many others (Gouba, 2008). Students with ID require some functional knowledge of Mathematics to achieve some degree of independence in their lives. For example, the ability to read time is essential to employees arriving at work on time and keeping their job ("if the short arm of a clock points to 3 and the long arm to 12, what is the time?"). Also, it is important to be able to identify one's phone number (functional mathematics) and name (functional literacy) on a bill to avoid paying the bill of a previous tenant in a rented accommodation ("identify your phone number (from a given set of numbers)". Self-efficacy has been found to be a good predictor of Mathematics achievements among mainstream students (Pajares, 1996).

There is a copious amount of information in the literature on the self-efficacy beliefs of individuals in mainstream educational settings. The first author has searched the literature for studies on the effects of self-efficacy of students with ID on their Mathematics achievements and it appears that no study of this nature exists.

Rationale

This study sought to establish: (1) the relationship between mathematics self-efficacy and intellectual disability; and (2) the relationship between the self-efficacy of students with borderline, mild and moderate ID and their achievements in Mathematics.

Method

Participants

Twenty-three High School students from Years 8 to 12 consisting of three, thirteen, and seven borderline, mild and moderate ID respectively participated in the study. The Mathematics self-efficacy instrument used in this study was an adaptation of the instrument described by Joet, Bressoux and Usher (2011). It was modified to make it relevant and appropriate to students with borderline, mild and moderate ID by including functional numeracy questions – from questions 4 to 25 (Table 1). Only questions 1 to 3 were retained from Joet, Bressoux and Usher's (2011) original Self-Efficacy items. The modified instrument (Table 1) had 25 items and each item was rated along five response categories including completely true (weighted 5), very true (weighted 4), moderately true (weighted 3), slightly true (weighted 2) and not at all true (weighted 1) (Table 1).

Statistical analyses were undertaken with *Minitab 17* (Minitab Statistical Software, 2010; Aylin, 2010). The self-efficacy instrument was administered orally and clarifications provided where necessary to ensure the participants understood the questions.

Table 1
Mathematics Self-Efficacy Items for students with ID

No.	Item
1	I am capable of solving math problems
2	I can solve geometry problems (e.g. identify shapes, calculate area and perimeter)
3	I am capable of getting good grades in math
4	I can solve addition problems involving single digit numbers
5	I can solve double-digit addition problems
6	I can subtract single-digit numbers
7	I can subtract double digit numbers
8	I can multiply single-digit numbers
9	I can multiply double-digit numbers
10	I can divide single-digit numbers
11	I can divide double-digit numbers
12	I can identify a number's place value
13	I know how to write numbers with their symbols up to 20
14	I know how to calculate the area of a rectangle
15	I am capable of measuring the sides and diagonals of a rectangle
16	I know how to add metres and centimetres
17	I know how many centimetres make a metre
18	I know how many cents make a dollar
19	I know how many minutes make 1 hour
20	I can count from 1 to 10
21	I can count from 1 to 20
22	I can count from 1 to 50
23	I can count from 1 to 100
24	I can count from 1 to 1000
25	I know my 12 times table

The self-efficacy instrument was administered at the commencement of the school year (Self-Efficacy 1). The students went through 6 months of instruction after which a second round of self-efficacy assessment (Self-Efficacy 2) was carried out. To measure the mathematics achievements of the students, the authors administered Test 1 - IMPELS (Enoma & Malone – in press), Test 2 - the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 - Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008) and Test 4 - Number knowledge Test (Okamoto & Case, 1996; Okamoto, 2004) on each occasion that the self-efficacy assessment was conducted.

Results and Discussion

Table 2 showed that 20 students (about 86%) of participants achieved >50% in the Self-Efficacy 1 assessment. When the self-efficacy assessment was repeated after 6 months of teaching (Self-Efficacy 2 – Table 2), similar results were obtained.

Table 2
Comparing pre-instruction Efficacy (Self-Efficacy 1) with Tests 1, 2, 3 & 4

Student	Year Level	Severity of ID	Self-Efficacy 1 (%)	Test 1 (%)	Test 2 (%)	Test 3 (%)	Test 4 (%)
1	10	Borderline ID	56.00	84.91	75.00	96.00	64.77
2	10	Borderline ID	84.80	99.58	75.00	98.00	65.91
3	8	Borderline ID	62.40	70.65	75.00	99.00	56.82
4	11	Mild ID	73.60	53.25	58.33	84.00	50.00
5	10	Mild ID	81.60	71.07	50.00	98.00	71.59
6	9	Mild ID	74.40	75.68	41.67	90.00	37.50
7	8	Mild ID	77.60	98.74	58.33	99.00	60.23
8	9	Mild ID	65.60	98.32	66.67	99.00	56.82
9	10	Mild ID	86.40	98.95	83.33	93.00	39.77
10	11	Mild ID	76.00	95.81	58.33	100.00	70.45
11	11	Mild ID	73.60	85.95	75.00	100.00	54.55
12	8	Mild ID	76.80	85.53	83.33	86.00	73.86
13	9	Mild ID	72.00	93.71	66.67	100.00	67.05
14	9	Mild ID	66.40	54.72	41.67	74.00	25.00
15	9	Mild ID	55.20	48.63	75.00	93.00	29.55
16	10	Mild ID	47.20	90.14	66.00	84.00	56.82
17	9	Moderate ID	60.00	41.30	16.67	56.00	29.55
18	12	Moderate ID	48.00	63.94	50.00	98.00	43.18
19	10	Moderate ID	64.80	62.68	66.67	99.00	52.27
20	8	Moderate ID	38.40	27.46	25.00	43.00	22.73
21	9	Moderate ID	52.80	51.36	66.67	90.00	50.00
22	11	Moderate ID	76.00	56.39	75.00	100.00	56.82
23	10	Moderate ID	58.40	60.97	75.00	84.00	39.77

Test 1 = IMPELS (Enoma & Malone, 2015 – in press), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 2008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

However, it was observed that some students with relatively high self-efficacy achieved low marks in mathematics as indicated by a student with a self-efficacy score of 60% achieving 41% in the mathematics Test 1 (Table 2). This suggests possible cognitive limitation or some degree of over-confidence or both. Similarly, some students with low self-efficacy achieved high marks in mathematics. An example of this case was demonstrated by a student who had a self-efficacy score of 23.2% and achieved 70.27% in

Test 1 (Table 3). An additional example of the low self-efficacy-high marks scenario was displayed by another student who achieved a relatively low self-efficacy score of 47.2% but achieved 90.14% in the mathematics Test 1 (Table 2). The situation described in the latter two examples has manifold implications: (1) students in this category possess some level of mathematics anxiety, (2) students in this group have the potential to do relatively well in mathematics and (3) As a result of mathematics anxiety, this cohort of students may not always perform to their potential in mathematics.

Table 3: Comparing post-instruction Efficacy (Self-Efficacy 2) with Tests 1, 2, 3 & 4

Name	Year Level	Severity of ID	Self-Efficacy 2 (%)	Test 1 (%)	Test 2 (%)	Test 3 (%)	Test 4 (%)
1	10	Borderline ID	78.40	95.39	83.33	98.78	73.86
2	10	Borderline ID	64.80	99.58	100.00	100.00	77.27
3	8	Borderline ID	76.80	77.99	75.00	98.78	80.68
4	11	Mild ID	83.20	97.06	66.67	97.56	65.91
5	10	Mild ID	86.40	99.79	83.33	100.00	76.14
6	9	Mild ID	68.80	97.69	66.67	84.15	45.45
7	8	Mild ID	65.60	93.08	75.00	100.00	67.05
8	9	Mild ID	68.80	98.74	50.00	98.78	65.91
9	10	Mild ID	61.60	88.68	83.33	93.90	53.41
10	11	Mild ID	72.00	96.86	91.67	100.00	76.14
11	11	Mild ID	73.60	91.19	91.67	100.00	59.09
12	8	Mild ID	72.80	92.87	66.67	98.78	73.86
13	9	Mild ID	72.00	99.16	58.33	100.00	68.18
14	9	Mild ID	65.60	87.00	8.33	78.05	43.18
15	9	Mild ID	23.20	70.27	25.00	84.15	34.09
16	10	Mild ID	56.80	91.19	83.33	98.78	50.00
17	9	Moderate ID	60.00	41.30	8.33	68.90	29.55
18	12	Moderate ID	53.60	83.23	58.33	97.56	47.73
19	10	Moderate ID	64.80	88.68	91.67	100.00	47.73
20	8	Moderate ID	40.80	37.32	41.67	45.73	22.27
21	9	Moderate ID	69.60	61.32	25.00	93.90	54.55
22	11	Moderate ID	76.00	90.36	75.00	98.78	56.82
23	10	Moderate ID	44.00	90.78	75.00	93.90	52.27

Test 1 = IMPELS (Enoma & Malone, 2015 – in press), Test 2 = the Delaware Universal Screening Tool for Number Sense Grade 2 (Delaware Department of Education, 2010), Test 3 = Streamlined Number Sense Screening Tool (Jordan, Glutting & Ramineni, 008), Test 4 = Number knowledge Test (Okamoto & Case, 1996).

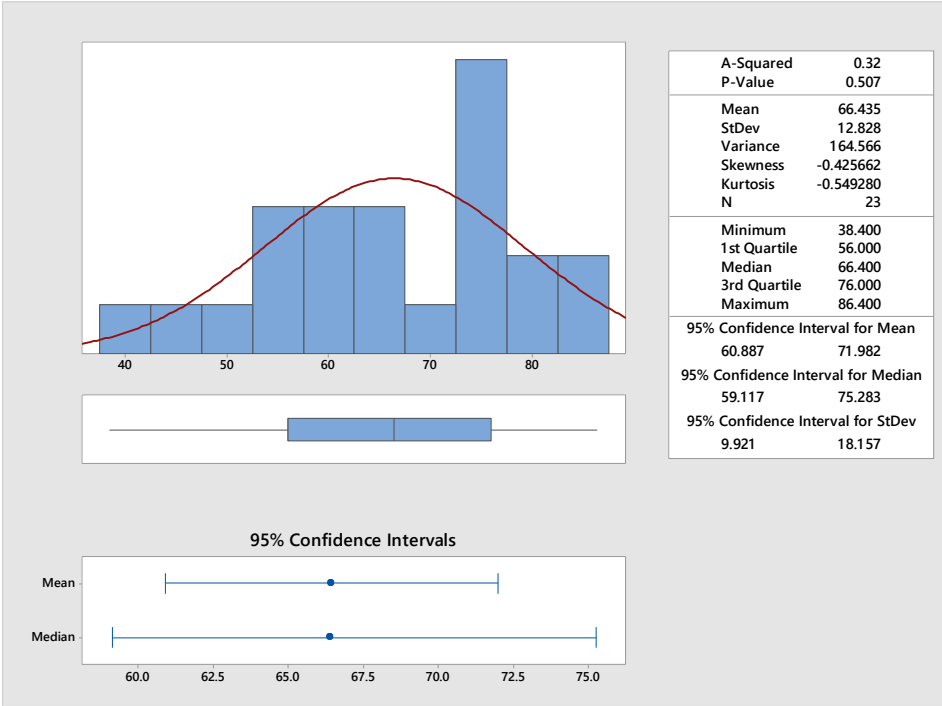

Figure 1: Distribution of Self-Efficacy 1 scores of students (pre- instruction).

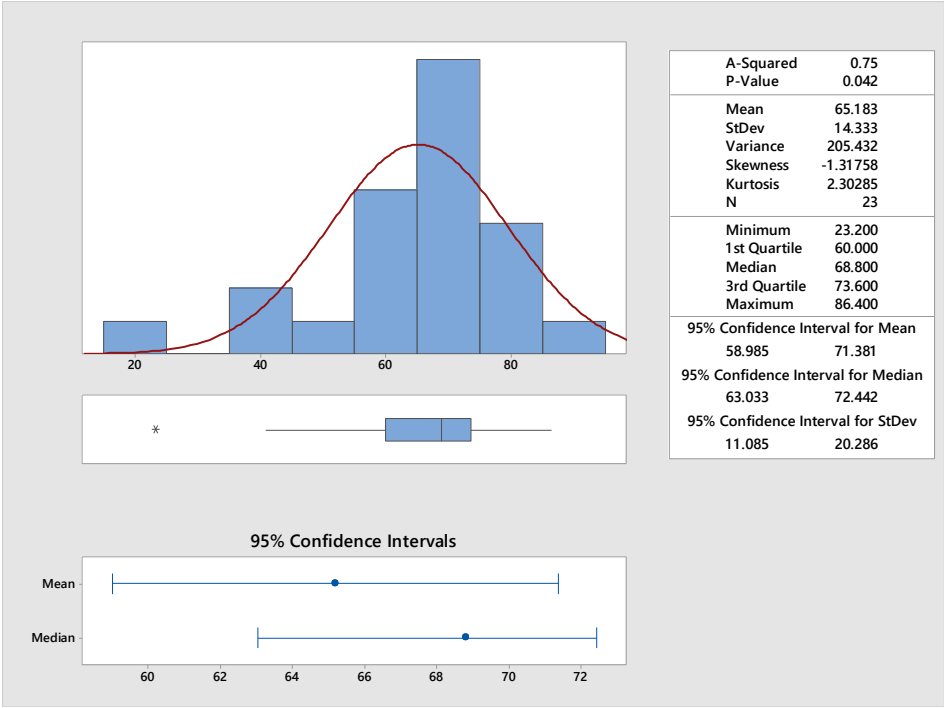

Figure 2: Distribution of Self-Efficacy 2 scores of students (post-instruction).

Students' self-efficacy scores ranged from 38.4% to 86.4% for Self-Efficacy 1 (Figure 1) and 23.20% to 86.40% for Self-Efficacy 2 (Figure 2). The mean self-efficacy scores were about the same, ie 83.04 (66.43%) for Self-Efficacy 1 (Figure 1) and 81.48 (65.18%) for Self-Efficacy 2 (Figure 2). Such impressive average self-efficacy scores of 66.43% (Self-Efficacy 1) and 65.18% (Self-Efficacy 2) demonstrate a belief in the majority of the students in their capabilities to do well in Mathematics. While self-efficacy has been

acknowledged as an important factor in academic accomplishments because of its positive relationship with effort and persistence (Bandura, 1993), it must borne in mind that individuals can only perform within the limit of their cognitive abilities.

Linear Regression Graphs

Considering the sample size was less than 30 (n = 23), Anderson-Darling normality tests were undertaken on both pre- and post-instruction data using MINITAB 17 statistical software (Minitab Statistical Software, 2010). The outcome was a mixed group of normally and non-normally distributed data. As a result, Pearson and Spearman Rho correlation coefficients were calculated. Pearson's pre-instruction correlation coefficients of 0.57 (P = 0.005), 0.33 (P = 0.122), 0.49 (P = 0.015), 0.48 (P = 0.02) and post-instruction correlation coefficients of 0.50 (P = 0.01), 0.37 (P = 0.07), 0.51 (P = 0.01) and 0.71 (P = 0.00) were obtained for Tests 1, 2, 3 and 4 respectively. Similarly, Spearman Rho pre-instruction correlation coefficient of 0.58 (P = 0.003), 0.24 (P = 0.26), 0.38 (P = 0.06), 0.47 (P = 0.02) and post-instruction correlation coefficients of 0.50 (P = 0.015), 0.27 (P = 0.20), 0.48 (P = 0.02) and 0.708 (P = 0.00) were obtained for Tests 1, 2, 3 and 4 respectively. The relationship between students' scores in Self-Efficacy 1 and their achievements in Mathematics showed a weak Pearson correlation coefficient (R) of 0.57, 0.33, 0.50 and 0.48 for Tests 1, 2, 3, and 4 respectively. Similar results were obtained for Self-Efficacy 2 with correlation coefficients of 0.50 (Test 1), 0.38 (Test 2) and 0.51 (Test 3). The only exception was Test 4 with a correlation coefficient of 0.71.

Figure 3 shows the relationship between Self-Efficacies 1 and 2 and the full scale IQ scores of students prior to instruction. Achievements in the self-efficacy assessments correlated weakly with their full scale IQ scores. Pearson correlation coefficients (R) of 0.36 and 0.30 were obtained for Self-Efficacy 1 (conducted at the beginning of the school year) and self-efficacy 2 (conducted 6 months after). This result shows that self-efficacy is an individual attribute as some students with high full scale IQ demonstrated lower self-efficacy than those students with IQ scores below them. The reverse was also true for some students.

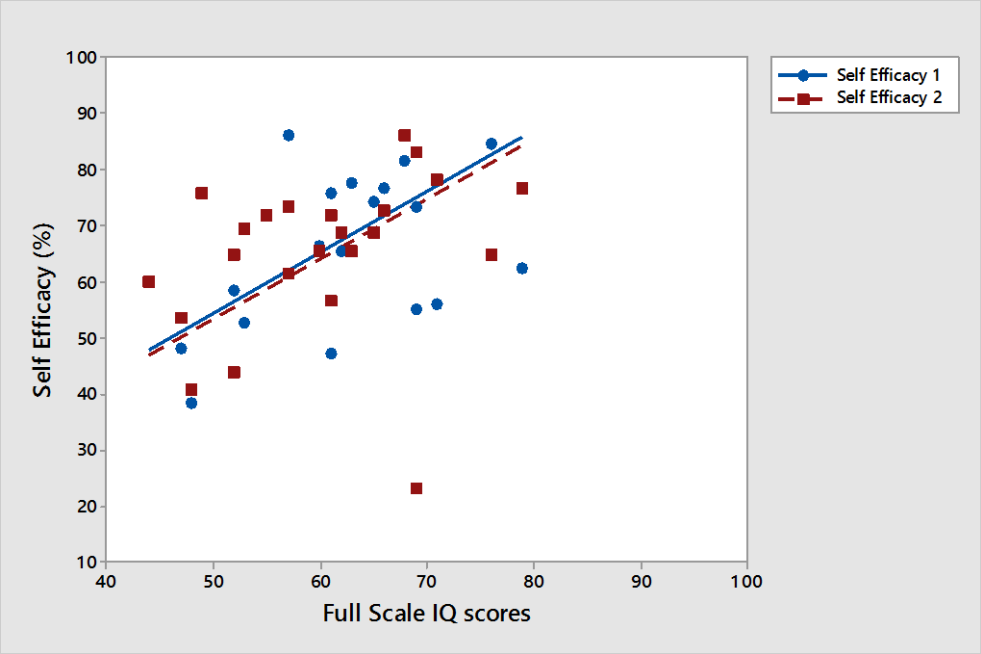

Figure 3: Relationship between Self-Efficacy and Full Scale IQ scores of students prior to instruction

Conclusion

The study found no strong correlation between the mathematics self-efficacy of students with ID and their achievements in Mathematics or with the categories of ID. The various scenarios that emerged from the study include students with low mathematics self-efficacy that achieved high scores in the tests, students with high mathematics self-efficacy that achieved low scores in the tests, students with high mathematics self-efficacy that achieved high scores in the tests and students with low mathematics self-efficacy that achieved low scores in the tests. These results further reinforced the importance of individualised mathematics education for students with ID.

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