



Math for life: Understanding the contribution of numeracy to the quality of life of adults with mild to profound intellectual disabilities

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ABSTRACT

Aim: Despite sustained interest in quality of life (QoL) within the field of intellectual disabilities (ID), the contributors to its enhancement remain unclear. This large-scale study (n = 567) aimed to investigate the relationship between numeracy and QoL in adults with ID—according to their severity—and to examine this relationship with regard to other functional academic skills.

Method: Participants included adults with mild, moderate, and severe to profound ID living in supported residential facilities. QoL was assessed using the Personal Outcomes Scale for Adults, encompassing eight dimensions categorised into three high-level factors: *independence* including self-determination; *social participation* including interpersonal relationships, social inclusion, and rights; and *well-being* including emotional, physical, and material well-being. A numeracy scale was designed with items related to the mathematical processing of the Vineland Adaptive Behavior Scales, Second Edition. Partial correlations and linear mixed models were used to not only confirm the existence of a relationship between numeracy and QoL but also investigate whether numeracy can be considered a unique predictor of QoL.

Results: Findings revealed that numeracy is significantly associated with QoL across all levels of ID, even when controlling for literacy, thereby emerging as a unique predictor of *personal development*, *self-determination*, and *social participation* among individuals with mild to moderate ID and of *self-determination* among those with severe to profound ID.

Conclusion: The results emphasise numeracy's importance in improving the QoL of adults with ID, highlighting the need to refine its role within the support frameworks designed for this population.

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1. Introduction

Over the past decades, the concept of *quality of life* (QoL) has received constant, in-depth attention in the field of intellectual disabilities (ID). QoL is defined as ‘an overall general well-being that comprises objective descriptors and subjective evaluations of physical, material, and emotional wellbeing together with the extent of personal development and purposeful activity, all by personal set of values’ (Felce & Perry, 1995, p.62). It extends beyond fulfilling basic needs to promoting dignity, respect, and self-determination (Verdugo et al., 2012). Currently, the most widely used theoretical framework for people with ID is the Schalock et al., (2002a), (2002b) model (Gómez et al., 2022). Empirically validated in different cultures and countries (Jenaro et al., 2005), it is founded on a scientific consensus that identifies eight essential dimensions of QoL, categorised into three high-level factors: (a) *independence* (including dimensions of personal development and self-determination), (b) *social participation* (including dimensions of interpersonal relationships, social inclusion, and rights), and (c) *well-being* (including dimensions of emotional, physical, and material well-being). The concept of QoL has provided a shared language to define high standards in services, particularly for adults with ID. Building on this conceptual foundation, Schalock et al., (2002a),(2002b) QoL model has contributed to a profound transformation of these services by operationalising QoL through self- and proxy-reported indicators across its core dimensions. It has thereby enabled a more structured approach to the design and evaluation of services aligned with those standards.

Considering QoL as a standard for services implies adopting person-centred approaches, designing interventions that promote the development of each of its eight key dimensions (Balboni et al., 2020). Although this perspective is increasingly supported by policymakers and professionals (Novella, 2010), QoL has been shown to result from an interdependence between environmental variables (e.g. living arrangement, employment status; Claes et al., 2012) and individual characteristics (e.g. age, severity of ID; Balboni et al., 2020; Claes et al., 2012) whose dynamic interaction conditions subjective experiences. In this context, *adaptive behaviour* has attracted growing interest as a personal factor that may contribute to improved QoL in people with ID. Defined as a set of social, practical and conceptual skills learned and applied to meet society’s expectations and demands (Tassé & Kim, 2023), adaptive behaviour has emerged as the main individual determinant of QoL in adults with ID, beyond age, gender or behavioural problems (Balboni et al., 2020). It plays a crucial role in the process of informed decision making for adults with ID by supporting individuals in identifying when and how to act, articulating their preferences, and anticipating the potential consequences of their choices on themselves and others (Wehmeyer & Garner, 2003). This decision making reinforces individuals’ feeling of control over their environments (Wehmeyer & Shogren, 2016) and provides opportunities to participate in community activities such as gaining paid employment (Bush & Tassé, 2017). Decision making and participation in relevant activities are considered essential dimensions of QoL, both by researchers and adults with ID (Ball et al., 2000; Wehmer, 2020). This underscores the importance of designing interventions for adults with ID that aim to strengthen adaptive behaviour, facilitating people’s functioning and adaptation to daily life requirements (Tassé et al., 2012).

In this respect, enabling adults with ID to acquire a set of skills essential to the emergence of adaptive behaviour, thus ensuring their QoL, should be prioritised. Learning such skills is a lifelong process, guided by the dynamic needs of individuals to improve their prospects for independent living and enhance their social inclusion (Ayres et al., 2011; Raspa et al., 2018). Previous interventions designed for people with ID have mainly focused on the acquisition of *functional skills* useful for self-care and independent functioning in home, vocational, and community environments (Clarke, Faragher, 2014; Faragher & Van Ommen, 2017; LaRue et al., 2016). Numerous programs have been validated for adults with ID (for a review, see Burns et al., 2019), most of which focus on acquiring the skills needed to perform basic activities of daily living, such as hygiene and cleaning tasks, dressing, and food preparation. Beyond these domains, relatively little attention has been paid to functional academic skills, which are nevertheless crucial, as their practical application in everyday contexts directly supports adaptation, independence, and social participation. From this perspective, *numeracy*—the functional use of mathematics in daily life (Geiger et al., 2015)—plays a fundamental role in a wide range of situations requiring mathematical processing, such as managing money and time, measuring quantities, or even finding one’s bearings in space, all of which enable individuals to act independently and participate fully in society. Although numeracy is associated with various positive indicators of QoL in typically developing people—namely better health, more favourable economic status, and increased social participation (Jonas, 2018; OECD, 2016; Tout & Gal, 2015)—its effects on the QoL of adults with ID remain unclear.

In 2005, Faragher and Brown conducted a case study of five adults with ID, revealing their highly varied educational needs in numeracy that primarily depend on activities performed in different life contexts. They suggested that improving numeracy would encourage this population to engage in more self-determined actions by facilitating deliberate *decision making* (e.g. deciding independently to purchase a garment while adhering to a set budget). This would help enhance the *sense of control* experienced in math-related activities of daily living and the individuals’ *perception* of their ability to meet the demands of their environment. A deeper understanding of the concept of time could promote the *autonomy* of adults with ID by enabling better apprehension of durations (e.g. awareness of the time remaining before moving on to a new task) and temporal successions (e.g. ability to place one date in relation to another) (Gaunt, 2022). The development of context-specific interventions involving tools such as visual aids or calculators is a promising way to improve the QoL of these individuals, by promoting their *engagement* and *participation* in everyday situations involving mathematical processing (Faragher, 2010, n = 1; Gaunt & Visnovska, 2024, n = 5). Drawing on the fundamental ideas of Schalock et al., (2002a),(2002b) approach to QoL and considering the importance that numeracy could have in the life of adults with ID, numeracy could be considered a key factor in improving the QoL of this population (Faragher & Van Ommen, 2017; Neveu & Rinaldi, 2025). Thus, policymakers and educational stakeholders have been called upon to reconsider the pedagogical approach to mathematics offered to students, focusing on the development of functional skills useful in adult life to support their autonomy and enhance their prospects for social inclusion (Neveu & Rinaldi, 2025).

Current related research is still preliminary and does not clearly depict how numeracy affects the QoL of adults with ID. Faragher

and Brown (2005) and Gaunt (2022) used case studies to ground their conclusions from observations of a limited number of participants in specific life contexts. The scope of their conclusions therefore remains limited, as no generalisation can be applied either to the population or to the different life contexts. Furthermore, determining whether the limitations identified among the participants are specifically related to poor numeracy or whether they can be explained by a confounding effect of other functional academic skills is unknown. Similar to numeracy, literacy—the ability to read, understand, and use written information in everyday situations—has also been identified as a factor influencing QoL. Relying primarily on qualitative data from very small samples ($n < 10$), early studies indicate that literacy supports access to employment and meaningful leisure activities, thereby promoting *community participation* and enriching *social interactions* (Garrels, 2019; Moni et al., 2011; Rubin et al., 2001). An accurate estimation of the unique contribution of numeracy and literacy is therefore crucial to supporting adults with ID, as it would clarify whether support programmes should focus on numeracy or other conceptual skills.

Thus, the present study aims to investigate, on a large scale, the relationship between numeracy and QoL in adults with ID while characterising it according to the severity of the ID and considering it independently of other functional academic skills. The study seeks to address two main research questions (RQs):

RQ 1. : Is numeracy significantly related to the QoL of adults with mild to severe ID?

RQ 2. : Can numeracy be considered a unique predictor of QoL in adults with mild to profound intellectual disabilities, beyond other functional academic skills such as literacy?

To answer the first RQ, we considered numeracy to be an embedded, structuring element of adaptive behaviour rather than a discrete functional skill. Given the lack of validated tools specifically targeting numeracy in this population, it was operationalised indirectly, through indicators of adaptive functioning. Thus, adaptive behaviour was assessed using the *Vineland Adaptive Behavior Scales*, 2nd edition (VABS-II, French version; Sparrow et al., 2005), which has been widely used in people with ID. A numeracy scale was also designed by extracting items related to mathematical processing from the VABS-II protocol. In accordance with recently conducted studies (Balboni et al., 2020; Faragher & Brown, 2005; Gaunt, 2022; Gaunt & Visnovska, 2024), the QoL was expected to be significantly related to not only the adaptive behaviour of adults with ID but also, and more specifically, to their numeracy skills.

RQ2 aimed to investigate whether numeracy could be considered a unique predictor of QoL of adults with ID, beyond the contribution of other functional academic skills such as literacy. Similar to the approach used for numeracy, a literacy scale was designed by selecting items related to the processing of written information from the VABS-II protocol. Because case studies by Faragher and Brown (2005) and Gaunt (2022) suggest that strong numeracy skills can help promote self-determination and autonomy in adults with ID, numeracy was expected to be a significant and unique predictor of participants' QoL, beyond literacy abilities.

2. Methods

2.1. Procedure

The protocol involved two questionnaires: the *Personal Outcomes Scale* for adults (POS-A; Van Loon et al., 2014) to evaluate QoL, and the VABS-II to assess adaptive behaviour. These questionnaires were completed during two assessment sessions conducted by trained psychologists ($n_{\text{total}} = 14$). The first session pertained to the administration of the POS-A, which was available in two forms: self-reported and proxy-reported. When participants were able to respond independently, the former was used; in all other cases, a caregiver (family member or professional with at least six months' knowledge of the participant) completed the latter. In all cases, respondents answered the questions orally. This session lasted approximately one hour. In the second evaluation session, VABS-II was administered individually to each participant's caregiver in its proxy-reported form. This session lasted approximately 1.5 h.

Initially, this protocol was administered to 1030 adults with various neurocognitive disorders, acquired brain injuries, or mental disorders residing in supported living facilities located in the French-speaking part of Belgium. This study focused on a subsample of the original research, comprising only individuals with ID ($n = 567$). The original database was provided to the authors with the consent of the research team overseeing its management. All analyses were carried out in collaboration with this team and in compliance with current ethical standards.

In this research, the numeracy and literacy scales were designed retrospectively referring to the original database. To develop the *numeracy scale*, eight clinical experts and/or researchers in numerical cognition were tasked with identifying, in the VABS-II protocol, items involving mathematical processing, encompassing all items that required number manipulation, arithmetic problem-solving, comprehension of measurement systems, and awareness of time, money, or space. The agreement criteria were set at 70 % (Edwards & Schipper, 2024). On average, selected items achieved an agreement rate of 94.6 %. To design the *literacy scale*, nine clinical experts and/or speech and language therapy researchers were tasked with identifying, in the VABS-II protocol, items involving the processing of written information, encompassing all items that required reading or writing in French. The agreement criteria were set at 70 % (Edwards & Schipper, 2024). On average, selected items achieved an agreement rate of 97.4 %.

2.2. Participants

The study sample comprised 567 French-speaking participants with ID (183 women; mean age = 46.4; standard deviation [SD] = 13.1 years), of whom 173 had mild ID (62 women; mean age = 44.9 ± 13.1 years), 207 had moderate ID (65 women; mean age = 46.0; SD = 12.5 years), and 187 had severe to profound ID (56 women; mean age = 48.1; SD = 13.7 years). All participants lived in supported

living facilities. Informational letters for caregivers, families, and residents were distributed in 25 centres. The letters to residents were written in easy-to-read, simple language. Participants were recruited and tested between November 2022 and February 2023 through the network coordinator of the supported living facilities. Informed consent was collected by evaluators from participants and their legal guardians, where applicable, prior to conducting assessments. This research was approved by the local ethics committee (reference number: 2021.12.21-VG-001).

To be included in this study, participants had to meet the three diagnostic criteria of the *Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition* (DSM-5; [American Psychiatric Association, 2013](#)) assessed through objective measurement and clinical evaluations. They had to show deficits in intellectual functions and experiential learning, confirmed by a clinical assessment conducted jointly by the psychiatrist and the psychologist at each residential centre (criterion A). They also had to display deficits in adaptive functioning with a total score of the VABS-II at least two SDs below the mean for an adult population of comparable age (criterion B). Finally, the intellectual and adaptive deficits had to be evident during the developmental period, as reported by the families during the anamnestic interview conducted during admission to the supported living facility (criterion C). Participants with cognitive impairments resulting from accidents, neurodegenerative pathologies, or psychiatric decompensation were excluded from this study. For each participant, the severity of their ID was determined during a clinical assessment conducted by the psychiatrist and the psychologist, in accordance with the severity levels described in the DSM-5.

In total, 80 % of the participants exhibited a mental disorder co-existing with ID. The main mental disorders were psychotic disorder (31.2 %) and autism spectrum disorder (27.4 %). Other comorbidities included emotional or affective disorder (12.1 %), neurodevelopmental disorder (11.9 %), personality disorder (9.4 %), reactive attachment disorder (4.1 %), post-traumatic stress disorder (0.7 %), and an undetermined mental disorder (3.2 %).

2.3. Instruments

2.3.1. Personal outcomes scales for adults

Participants' QoL was assessed using the POS-A (French version) intended for adults aged 18 and over. The questionnaire was administered in its self-reported version to participants (mild ID: 87.3 %; moderate ID: 59.4 %; severe to profound ID: 6.4 %) or in its proxy-reported version to caregivers who could observe them daily in different life contexts. The French version of the POS-A has good internal consistency, with a Cronbach's α of .80 and .85 for the self- and proxy-reported scales, respectively.

The POS-A comprises 48 items encompassing the 8 essential dimensions of QoL described by [Schalock et al., \(2002a\),\(2002b\)](#), categorised into three high-level factors. The *independence* dimension includes (1) the *personal development* subdimension, concerning access to education and the development of the participant's personal skills, and (2) the *self-determination* subdimension, concerning choices, decision making, and the way in which individuals deals with personal goals and objectives. The *social participation* factor includes the subdimensions of (3) *interpersonal relations*, pertaining to the relationships between the individual and his or her social network (e.g. family, friends) and the support received; (4) *social inclusion*, which refers to the integration and participation of the person in community life; and (5) *rights*, which concerns both human (e.g. respect, dignity) and legal (e.g. citizenship) rights. Finally, the *well-being* factor includes the subdimensions of (6) *emotional well-being*, which refers to personal satisfaction, self-esteem, and absence of stress; (7) *physical well-being*, which deals with health, mobility, and leisure; and (8) *material well-being*, which concerns the individual's financial situation, living conditions, and assets.

Participants or their caregivers were asked to provide oral responses rated on a three-point Likert scale. For each high-level dimension—*independence*, *social participation* and *well-being*—scores were derived by summing the points achieved across its respective subdimensions, with maximal values of 72, 108, and 108, respectively. An overall QoL score was also computed by summing the scores of the three high-level dimensions (max. score = 288).

2.3.2. Vineland adaptive behavior scales, 2nd edition

Adaptive behaviour was assessed using VABS-II for individuals aged 1 year and over because the French version of the third edition had not yet been published at the time of data collection. The VABS-II comprises 383 items covering 11 subdimensions classified into 4 high-level dimensions. The *communication* dimension includes (1) the *receptive* subdimension, pertaining to the way in which the person understands orally given information, (2) the *expressive* subdimension, pertaining to what the subject can say, and (3) the *written* subdimension concerning the person's reading and writing skills. The *everyday life* dimension includes (4) the *personal* subdimension, concerning the skills needed to take care of oneself (e.g. eating, dressing), (5) the *domestic* subdimension, concerning the skills needed to take care of one's home (e.g. cleaning, washing clothes), and (6) the *community* subdimension pertaining to the skills needed to live in the community (e.g. managing time, money, accessing employment). The *socialisation* dimension includes (7) the *interpersonal relations* subdimension, which refers to the skills needed to stay in contact with others; (8) the *play and leisure* subdimension, which involves the skills needed to play and use one's free time; and (9) the *adaptation* subdimension, which concerns how the subject shows responsibility and sensitivity to others. Finally, the *motor skills* dimension includes the subdimensions of (10) *gross* and (11) *fine* motor skills. However, because this dimension is intended for children under the age of 7, it was not included in the original protocol.

The numeracy scale comprises 21 items spread across 4 subdimensions of VABS-II. Most of them belonged to the *community* subdimension (item numbers 4, 17, 18, 19, 21, 22, 23, 27, 28, 30, 32, 33, 37, 41, 43, and 44; $n = 16$; e.g. 'discriminates between bills of different denominations' (item 19), 'points to current or other date on calendar when asked' (item 21), 'budgets for monthly expense' (item 43)). The others belonged to the *domestic* subdimension ('uses microwave oven for heating, baking or and cooking (that is, sets time and power setting, etc.)' (item 10), 'uses microwave oven for heating, baking or and cooking (that is, turns burners on and off, sets

oven temperature, etc.)' (item 20) and 'prepares food from ingredients that require measuring, mixing, and cooking' (item 21; $n = 3$); the *personal* subdimension ('uses a thermometer to take own or another's temperature' (item 37; $n = 1$)), and the *play and leisure* subdimension ('plays simple card or board games based only on chance' (item 20; $n = 1$)). The internal consistency of the numeracy scale was excellent, with McDonald's omega of 0.94.

The literacy scale comprises 29 items spread across two subdimensions of VABS-II. Most of them belonged to the *writing* subdimensions (item numbers 1–25; $n = 25$; e.g. 'prints at least 10 simple words from memory' (item 10), 'puts lists of words in alphabetical order' (item 15), 'writes advanced correspondence at least 10 sentences long; may use computer' (item 22)). The others belonged to the *personal* subdimensions ('takes medicine as directed (i.e., follows directions on label)' (item 36), 'follows directions for health care procedures, special diet, or medical treatments' (item 39; $n = 2$) and the *community* subdimensions ('orders a complete meal in a fast-food restaurant' (item 25) and 'demonstrates computer skills necessary to perform complex tasks' (item 31; $n = 2$)). The internal consistency of the literacy scale was good, with McDonald's omega of 0.80.

For each participant, VABS-II was administered to their caregiver. For each item, two points were awarded if the participant was able to perform the behaviour regularly and independently, whereas one point was awarded if he or she performed the behaviour occasionally or with partial autonomy. No point was awarded if the participant never performed the behaviour alone. Three raw scores were computed from the VABS-II protocol: total adaptive behaviour (maximum = 766), numeracy (maximum = 42), and literacy (maximum = 58). Both the numeracy and literacy scores are embedded within the adaptive behaviour score, as they are calculated from items that form part of the total score.

2.4. Analyses

Results were analysed using Jamovi 2.3.28 software. First, descriptive analyses were conducted to provide information on the three groups studied (i.e. mild, moderate, and severe to profound ID). Analyses of variance (ANOVAs) and post-hoc analyses were performed on mean scores, using group as a between-subjects factor, to ensure that the three groups differed on all variables examined. Eta squared were reported as effect sizes of ANOVAs with scores (η^2) of .01, .06, and .14, considered weak, medium, and strong, respectively. Cohen (1988) were reported as effect sizes in post-hoc analyses with scores (d) of .20, .50 and .80, considered weak, medium and strong, respectively.

To determine whether numeracy is significantly related to QoL (RQ1), Pearson's correlations were performed on the three groups, focusing on: (1) the relationship between adaptive behaviour and QoL; (2) the relationship between literacy and QoL; and (3) the relationship between numeracy and QoL. Results of analyses conducted prior to these correlations indicated a strong significant correlation between numeracy and literacy ($r = .85$), reflecting a high degree of common variability owing to participants' general level of education and cognitive factors underlying the development of these two domains (e.g. executive functions, reasoning, etc.). Partial correlations controlling for literacy were therefore systematically used to account for the influence of this factor and focus exclusively on the numeracy–QoL relationship. Based on Cohen (1988), correlations (r) of .10, .30, and .50 were considered weak, moderate, and strong, respectively.

Only variables significantly correlated with numeracy were then considered in the nested linear mixed models (LMMs) conducted in the third stage, to examine whether numeracy could be considered a unique predictor of QoL, beyond the effects of other functional academic skills such as literacy (RQ2). To do this, numeracy and literacy were included in all LMMs as fixed effects to determine the explanatory power of each of these two predictors. The supported living facilities were considered a random effect. For each group, analyses were conducted on the overall QoL score and on the three high-level dimensions. Subdimensions were analysed only when numeracy emerged as a significant specific predictor of the overarching dimension. Cohen (1988) were reported as effect sizes of each significant fixed effect, with scores (d) of .20, .50 and .80 considered weak, medium and strong, respectively. Variation inflation factor (VIF) scores were calculated using R software (v2024.12.1) for each LMM conducted. With values between 1.61 and 1.97, the VIF scores revealed a low level of multicollinearity, indicating that the strong correlation between numeracy and literacy does not compromise the independence of these two factors in the models. Finally, power analyses conducted with GLiMMPS (v3.1.3) suggested that at least 192 participants were required to provide strong statistical power ($>.80$) and produce small effect sizes ($d \leq .20$).

Table 1

Mean scores of adaptive behaviour, numeracy, literacy, and quality of life (QoL) and group comparison.

	Mild ID (n = 173)		Moderate ID (n = 207)		Severe to profound ID (n = 187)		Group comparison	
	Mean (SD)	Range (min-max)	Mean (SD)	Range (min-max)	Mean (SD)	Range (min-max)	$F(2567)$	η^2
Adaptive behaviour	580 (122)	10–745	457 (143)	0–719	215 (116)	16–540	381***	.57
Numeracy	19.27 (9.37)	0–40	8.79 (8.80)	0–34	0.51 (1.10)	0–7	285***	.50
Literacy	29.55 (14.77)	0–56	14.41 (12.81)	0–52	1.26 (3.90)	0–24	274***	.49
QoL total	110.33 (11.20)	72–139	105.27 (12.86)	72–134	98.65 (14.28)	62–123	129***	.31
Independence	28.46 (3.70)	15–36	26.33 (4.08)	14–35	20.04 (4.37)	12–31	212***	.43
Social participation	39.46 (5.39)	23–52	37.59 (5.94)	22–51	31.74 (5.83)	21–47	90.5***	.24
Well-being	42.41 (4.89)	26–53	41.43 (5.27)	28–52	37.95 (6.31)	22–50	33***	.10

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. ID: intellectual disabilities; SD: standard deviation

3. Results

3.1. Descriptive analyses

Table 1 summarises the mean scores of adaptive behaviour, numeracy, literacy, and QoL for participants in the three groups, as well as the ANOVA results conducted for group comparisons. The ANOVA on the mean score of adaptive behaviour revealed a significant group effect ($p < .001$). Post-hoc analyses revealed better adaptive behaviour in participants with mild ID than in those with moderate ID ($t(564) = 9.34$; $p < .001$, $d = 0.96$), who outperformed those with severe-profound ID ($t(564) = 18.67$; $p < .001$, $d = 1.88$).

With regard to numeracy, the ANOVA on the mean score revealed a significant group effect ($p < .001$). The numeracy score of participants with mild ID was higher than that of those with moderate ID ($t(564) = 13.6$; $p < .001$, $d = 1.41$), who outperformed those with severe to profound ID ($t(564) = 11.0$; $p < .001$, $d = 1.11$). With regard to literacy, the ANOVA revealed a significant group effect ($p < .001$). The scores of participants with mild ID were significantly higher than those of participants with moderate ID ($t(564) = 12.8$; $p < .001$, $d = 1.32$), which, in turn, were higher than those of participants with severe to profound ID ($t(564) = 11.4$; $p < .001$, $d = 1.15$).

The ANOVA conducted on the total QoL score also revealed a significant group effect ($p < .001$). As before, participants with mild ID had a better QoL than did those with moderate ID ($t(564) = 3.81$; $p < .001$, $d = .39$), who outperformed those with severe to profound ID ($t(564) = 12.02$; $p < .001$, $d = 1.21$). Moreover, ANOVAs demonstrated a significant group effect for the independence dimension of QoL ($p < .001$) which decreased as the severity of impairment increased (mild vs. moderate ID, $t(564) = 5.09$, $p < .001$, $d = .52$; moderate vs. severe to profound ID, $t(564) = 15.32$, $p < .001$, $d = 1.55$). Social participation was also affected ($p < .001$), decreasing as the severity of impairment increased (mild vs. moderate ID, $t(564) = 3.16$, $p < .001$, $d = .33$; moderate vs. severe to profound ID, $t(564) = 10.11$, $p < .001$, $d = 1.02$). Finally, the ANOVA performed on well-being revealed a significant group effect ($p < .001$). Although participants with mild and moderate ID had comparable levels of well-being ($t(564) = 1.72$, $p = .20$, $d = .18$), they had better well-being than did participants with severe to profound ID ($t(564) = 6.23$, $p < .001$, $d = .63$).

3.2. Assessing the relationship between numeracy and QoL in adults with ID through correlation analyses (RQ1)

Pearson's correlations revealed that adaptive behaviour was related to the total QoL score for the three groups (mild, moderate, and severe to profound ID: $p < .001$; Table 2). More specifically, the adaptive behaviour of the three groups was associated with the independence (mild, moderate, and severe to profound ID: $p < .001$) and social participation (mild, moderate, and severe to profound ID: $p < .001$) dimensions. Adaptive behaviour was only associated with the well-being dimension for participants with moderate and severe to profound ID ($p < .001$).

Pearson's correlations also revealed that literacy was related to the total QoL score for participants with moderate ($p = .002$) and severe to profound ($p = .04$) ID. More specifically, the literacy of the three groups was associated with the independence dimension (mild ID: $p = .003$; moderate ID: $p < .001$; severe to profound ID: $p < .001$).

Partial correlations controlling for literacy (Table 3) revealed a significant relationship between numeracy and the total QoL score for all three groups (mild ID: $p = .006$; moderate ID: $p = .003$; severe to profound ID: $p = .02$). With regard to the three high-level dimensions of QoL, partial correlations indicated a significant association between numeracy and independence (mild ID: $p = .003$; moderate ID: $p < .001$; severe to profound ID: $p = .01$) and between numeracy and social participation (mild ID: $p = .002$; moderate ID: $p = .03$; severe to profound ID: $p = .03$) in the three groups. Numeracy was not associated with well-being (mild ID: $p = .47$; moderate ID: $p = .29$; severe to profound ID: $p = .13$) in any of the groups.

3.3. Assessing the predictive value of numeracy on QoL in adults with ID through linear mixed models (RQ2)

Finally, LMMs were conducted to investigate the unique predictive value of numeracy on the QoL of participants in the three groups (Table 4). Among participants with mild ID, eight LMMs were conducted to determine the specific predictive value of numeracy on (1) the QoL score, (2) two of the three QoL dimensions (independence and social participation) and (3) five of the eight QoL subdimensions (personal development, self-determination, interpersonal relationships, social inclusion and rights). For each model, numeracy and literacy were considered fixed effects, while the supported living facility was included as a random effect. Results revealed that numeracy specifically predicted participants' QoL ($p_{\text{numeracy}} = .001$, $p_{\text{literacy}} = .19$), more specifically, independence ($p_{\text{numeracy}} = .001$, $p_{\text{literacy}} = .94$), personal development (numeracy: $t(173) = 2.91$, $p = .004$, $d = .05$; literacy: $t(173) = .84$, $p = .40$) and self-determination (numeracy: $t(173) = 2.17$, $p = .03$, $d = .09$; literacy: $t(173) = -.69$, $p = .49$). Numeracy was also shown to be a specific predictor of social

Table 2

Person's correlations between adaptive behaviour, literacy, and quality of life (QoL).

	Mild ID		Moderate ID		Severe to profound ID	
	Adaptive behaviour	Literacy	Adaptive behaviour	Literacy	Adaptive behaviour	Literacy
QoL total score	.34***	.08	.36***	.16*	.46***	.15*
Independence	.42***	.23**	.44***	.25***	.49***	.25***
Social participation	.33***	.06	.30***	.12	.43***	.15*
Well-being	.06	-.07	.21***	.08	.33***	.43

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. ID: intellectual disabilities.

Table 3

Partial correlations between numeracy and quality of life (QoL), controlling for literacy.

	Mild ID	Moderate ID	Severe to profound ID
QoL total score	.21**	.21**	.17*
Independence	.22**	.29***	.18*
Social participation	.23**	.15*	.16*
Well-being	.06	.07	.11

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. ID: intellectual disabilities**Table 4**

Summary of linear mixed models conducted to investigate the predictive value of numeracy on the participants' quality of life.

	Mild ID		Moderate ID		Severe to profound ID	
	<i>t</i> (173)	<i>d</i>	<i>t</i> (207)	<i>d</i>	<i>t</i> (187)	<i>d</i>
QoL total score						
Numeracy	3.28***	.04	2.72**	.06	1.93	
Literacy	-1.30		-.68		.11	
Independence						
Numeracy	3.25***	.09	3.94***	.11	2.10*	.39
Literacy	.07		-.41		1.50	
Social participation						
Numeracy	3.04**	.02	2.06*	.04	1.73	
Literacy	-1.43		-.55		-.22	

Note. * $p \leq .05$, ** $p \leq .01$, *** $p \leq .001$. *d* [.20-.40], [.50-.70] and $\geq .80$ are small, medium and large, respectively. ID: intellectual disabilities

participation ($p_{\text{numeracy}}=.003$, $p_{\text{literacy}}=.16$), specifically predicting social inclusion (numeracy: $t(173) = 2.31$, $p = .02$, $d = .06$; literacy: $t(173) = -1.06$, $p = .29$) but not interpersonal relationships (numeracy: $t(173) = 3.13$, $p = .002$, $d = .07$; literacy: $t(173) = -2.04$, $p = .04$, $d = -.03$) or rights (numeracy: $SE=.03$, $t(173) = .84$, $p = .40$; literacy: $SE = .002$, $t(173) = .24$, $p = .81$).

Among participants with moderate ID, eight LMMs were conducted to determine the specific predictive value of numeracy on (1) the QoL score, (2) two of three QoL dimensions (independence and social participation) and (3) five of the eight QoL subdimensions (personal development, self-determination, interpersonal relationships, social inclusion and rights). For each model, numeracy and literacy were considered fixed effects, while the supported living facility in which the participant lived was considered a random effect. The results revealed that numeracy specifically predicted participants' QoL ($p_{\text{numeracy}}=.01$, $p_{\text{literacy}}=.50$), particularly their independence ($p_{\text{numeracy}} < .001$, $p_{\text{literacy}}=.68$). More specifically, numeracy was a significant predictor of personal development (numeracy: $t(207) = 4.80$, $p < .001$, $d = .15$; literacy: $t(207) = -.75$, $p = .45$) but not of self-determination (numeracy: $t(207) = 1.80$, $p = .07$; literacy: $t(207) = .18$, $p = .90$). Numeracy was also shown to be a specific predictor of social participation ($p_{\text{numeracy}}=.04$, $p_{\text{literacy}}=.59$). Examined separately, numeracy predicted neither interpersonal relationships (numeracy: $t(207) = 1.84$, $p = .07$; literacy: $t(207) = -.15$, $p = .90$) nor social inclusion (numeracy: $t(207) = 1.36$, $p = .17$; literacy: $t(207) = -1.08$, $p = .28$) or rights (numeracy: $t(207) = 1.66$, $p = .09$; literacy: $t(207) = .01$, $p = .99$).

Among participants with severe to profound ID, five LMMs were conducted to determine the specific predictive value of numeracy on (1) the QoL score, (2) two of the three QoL dimensions (independence, social participation, and well-being) and (3) two of the eight QoL subdimensions (personal development, self-determination). For each model, numeracy and literacy were considered fixed effects, while the supported living facility was considered a random effect. Results revealed that numeracy was not a significant predictor of the participants' QoL ($p_{\text{numeracy}}=.30$, $p_{\text{literacy}}=.63$). However, it predicted the participants' independence ($p_{\text{numeracy}}=.04$, $p_{\text{literacy}}=.13$). It was a specific predictor of self-determination (numeracy: $t(187) = 2.79$, $p = .01$, $d = .55$; literacy: $t(187) = .80$, $p = .42$) but not personal development (numeracy: $t(187) = .70$, $p = .48$; literacy: $t(187) = 1.89$, $p = .06$). Finally, no predictive value of numeracy on social participation ($p_{\text{numeracy}}=.09$, $p_{\text{literacy}}=.82$) was observed.

4. Discussion

This study aimed to not only conduct a large-scale investigation of the relationship between numeracy and QoL in adults with ID—according to the severity of the ID—but also examine this relationship with regard to other functional academic skills.

First, the results revealed a moderate association between adaptive behaviour and QoL. Specifically, adaptive behaviour was found to be related to not only independence and social participation among participants in all three groups but also well-being among individuals with moderate and severe to profound ID. These results are consistent with Simoes et al.'s (2016) and Balboni et al.'s (2020) findings, which revealed that although adaptive behaviour was a robust predictor of independence and social participation in adults with mild to moderate ID, the effects on well-being were more nuanced, with generally weak or non-significant correlations. In their discussion, Balboni et al. (2020) highlight the value of conducting more in-depth investigations to better understand the nature of the shared variance between adaptive behaviour and QoL. Numeracy, present in four of the nine subdimensions of adaptive behaviour considered in this study, emerged as a key cross-cutting skill promoting the transfer of skills between different areas of daily life. Given its apparent importance in the process of informed decision making and participation in community activities, it may also be one of the

foundations of QoL for adults with ID, making it a particularly relevant dimension to investigate.

In this study, numeracy was found to significantly contribute to the QoL of adults with ID, even after accounting for the effects of literacy. By situating numeracy in relation to other functional academic skills, this study provides initial evidence of its unique and independent influence on QoL in this population. Although literacy is linked with QoL, it does not appear to be a unique predictor. This may be surprising, given that literacy is often regarded a determinant of QoL in adults with ID, notably through its role in fostering community participation and social interactions (Garrels, 2019; Moni et al., 2011; Forts & Luckasson, 2011). However, published studies remain limited in scope, with small sample sizes and a reliance on qualitative interviews rather than standardised measures. While such approaches provide valuable contextual insights, they capture only certain aspects of QoL and may overestimate the role of literacy, overlooking dimensions such as emotional well-being or social inclusion. In addition, literacy has often been defined in broad, general terms and applied to individual situations without clear functional contextualisation. In this study, by contrast, literacy and numeracy were both operationalised through items derived from the VABS-II, which, despite some limitations, enabled a comparison of their contributions. Our findings suggest that while literacy may not be an isolated determinant of QoL, it interacts with other functional academic skills—particularly numeracy—in supporting adaptation, autonomy, and participation. Beyond methodological considerations, another explanation may be advanced. A potential third factor to be considered in future research pertains to the educational opportunities afforded to people with ID throughout their life, as well as opportunities for participation in adulthood. Literacy has traditionally been emphasised in curricula and is more socially valued, which may have reinforced its assumed role as a determinant of QoL. Numeracy, by contrast, is often perceived as more complex, less directly useful, or even reserved for populations without ID. Therefore, our findings may partly reflect these asymmetries in access, valuation, and participation opportunities, rather than the intrinsic contribution of each skill to QoL.

This large-scale ($n = 567$) study is the first to establish an empirical link between numeracy and QoL, with evidence that extends to all adults with ID, regardless of the severity of the disability, thereby extending beyond Faragher and Brown's (2005) and Gaunt's (2022) findings, which were drawn from observations made on a limited number of participants ($n = 11$). More specifically, our findings have revealed that numeracy is a unique predictor of *personal development* (i.e. education and learning of personal skills) in adults with mild to moderate ID. Mastering personal skills useful in everyday life, also known as 'daily living skills', is a major issue for this group, considered one of the main levers for their functional autonomy (Lussier-Desrochers et al., 2014; Woolf et al., 2010). Several daily living skills reported here, such as following a set return time, evaluating product prices before purchase, creating a monthly budget, or using a thermometer to take one's temperature, involves mathematical processing. They are underpinned by not only an accurate perception of time but also numerical reasoning (e.g. transcoding or number comparisons) and arithmetic problem solving (e.g. addition or subtraction solving). This may partly explain why numeracy appears to be a key element in the personal development of adults with mild to moderate intellectual disabilities.

Interestingly, numeracy is a specific predictor of *self-determination*, particularly among individuals with mild ID, suggesting that it can facilitate greater engagement in self-determined actions. Although this relationship has not been extensively explored, it could be hypothesised—drawing on Wehmeyer's (2003) functional model of self-determined behaviour—that numeracy supports several of the volitional actions that enable individuals to act as causal agents. According to this model, self-determination involves a set of inter-related skills, including autonomous decision-making, goal-setting, problem-solving, and self-regulation. Numeracy could play a facilitative role in each of these areas. For instance, autonomous decision making may often involve weighing options using numerical reasoning (e.g. identifying the right bus by reading its number, comparing prices before making a purchase, or checking one's watch to assess the time available before choosing an activity), which presupposes numeracy skills. In goal setting, individuals may need to plan sequenced actions, allocate time and resources, and monitor progress—all of which require numerical processing. Problem solving in daily contexts, such as adjusting to changing circumstances or working within fixed budgets, similarly relies on mathematical reasoning to evaluate constraints and generate effective strategies. Finally, self-regulation may be supported by numeracy through the ability to track one's behaviours or outcomes numerically (e.g. time management, budgeting), anticipate deviations, and adapt accordingly.

The results from this study could also be interpreted through the lens of the Self-Determination Theory (Ryan & Deci, 2000), according to which, self-determined motivation and behaviour emerge when three basic psychological needs—autonomy, competence, and relatedness—are supported. Numeracy may contribute to fulfilling these needs in various ways, enabling individuals to engage more fully in self-directed and meaningful actions. From this perspective, it could enhance individuals' sense of competence by allowing them to navigate everyday tasks involving numbers—such as managing money, planning time, or comparing options—potentially reinforcing their confidence in acting independently. It could also support autonomy by equipping individuals with the tools needed to make informed choices and solve problems without constant external guidance. Although these hypotheses need to be empirically tested, they offer a promising framework for interpreting the observed association between numeracy and self-determination. This perspective also uncovers new avenues for research, suggesting that numeracy may contribute to not only cognitive or academic performance but also the broader capacity of adults with ID to exercise control and agency in their everyday lives.

Numeracy also emerged as a significant predictor of self-determination in adults with severe to profound ID. This finding is unexpected, given that this level of ID is typically associated with marked limitations in the acquisition and use of conceptual skills such as literacy and numeracy, requiring high-level support for tasks involving abstract reasoning (American Psychiatric Association, 2013). There are, however, several possible interpretations that could explain this result, from conceptual, clinical, and statistical perspectives. First, it should be interpreted considering how numeracy was operationalised in this study—through adaptive behaviour items that reflect practical rather than formal real-life competencies. In this context, numeracy may reflect the ability to engage with basic quantitative or sequencing demands embedded in routine activities (e.g. following steps, anticipating quantities, understanding

time-related cues), often with the support of familiar caregivers or environmental scaffolding. These rudimentary competencies, even when limited, may still support participation in decision making or self-regulated routines, contributing to expressions of self-determination adapted to the person's level of functioning. Moreover, this association could reflect proxy-reported perceptions of numeracy-related behaviours, which may in turn correlate with caregivers' recognition of emerging autonomy or choice-making capacities. Another possible explanation for these results, anchored in statist considerations, could lie in the floor effect identified in numeracy scores. Among the 187 adults with severe to profound ID, 141 (75.4 %) scored zero in numeracy, lowering the group's average score to 0.51. The low dispersion of scores seemingly reduced inter-individual variability and provided disproportionate weight to participants who obtained a score above zero, thereby likely overestimating the predictive effect of numeracy on self-determination in this population (Liu & Wang, 2021; McBee, 2010). Accordingly, caution is warranted when interpreting the results of these analyses. Nonetheless, the findings highlight the need for future research to further examine how self-determination manifests in people with more severe cognitive impairments and to develop tools that are sensitive to non-verbal, assisted, or co-constructed forms of autonomous behaviour.

Finally, the findings suggest that numeracy has a broader impact on QoL among adults with ID than previously suggested by Faragher and Brown (2005) and Gaunt (2022). It appears to be associated with not only *independence* but also *social participation*. More specifically, it is a significant predictor of *social inclusion* among adults with mild ID. One possible explanation is that individuals with mild ID often have greater access to social and occupational environments (Dusseljee et al., 2011), where numeracy-related demands—such as interpreting schedules, handling money, or navigating public transport—are embedded in everyday interactions. Numeracy may therefore play a facilitating role in accessing, sustaining, and benefiting from these forms of participation. However, despite these findings, our understanding of how numeracy concretely supports social inclusion in this population remains limited. Currently, no validated tool exists that is specifically designed to assess numeracy skills in adults with ID. While instruments like the VABS-II include items related to numeracy in daily activities, their scope does not include capturing the variety and complexity of numeracy demands encountered in real-life social contexts. Further research is therefore necessary to better identify and characterise the numeracy competencies that underpin meaningful participation and inclusion for adults with ID.

This study should be interpreted in light of several methodological limitations. The first concerns the assessment of numeracy skills, which relied on a proxy-reported questionnaire rather than direct measures, thereby limiting the interpretation of the results, as it does not fully capture the diversity of mathematical situations encountered by participants or the complexity of the skills required to address them. From this perspective, developing measures that assess numeracy in adults with intellectual disabilities beyond standardised evaluations administered in an isolated and decontextualised manner becomes necessary. The challenge will then be to design scales that can be applied directly within individuals' everyday environments to better capture the specificity of their needs. Future studies should also aim to broaden the study population by including not only individuals living in supported living facilities but also those living at home with a caregiver or in (semi-) independent housing, as they face very different challenges compared to those in institutional environments. This would provide a better understanding of not only the relationship between numeracy and QoL but also the influence of different life contexts on this relationship. Finally, this study is limited by its correlational design, which precludes the establishment of causal relationships between numeracy and QoL. To examine these associations more precisely, future research should consider longitudinal or intervention-based approaches. Beyond determining the effectiveness of interventions, this will help identify the mechanisms through which numeracy supports autonomy, participation, and well-being and inform the design of inclusive educational and support practices tailored to different levels of ID.

5. Conclusion

This study is the first to provide evidence that numeracy specifically predicts QoL of adults with ID. Conducted on a large scale, it is particularly significant as it includes participants across the entire ID spectrum, from mild to profound. It advances our understanding of the phenomenon by revealing that numeracy specifically predicts *personal development* and *self-determination* in adults with mild to moderate ID and *social participation* in individuals with mild ID. Numeracy scores among adults with severe to profound ID are close to zero, suggesting that their needs are more fundamental. More broadly, the study findings highlight the need for a clearer bridge between education and adult life in people with ID. Currently, academic learning is often confined to school settings, with preparation for adulthood primarily focusing on functional skills taught separately. This division may limit the potential for these skills to translate into autonomy, inclusion, and meaningful participation. An approach grounded in Educational Quality of Life (Faragher & Van Ommen, 2017)—that is, an education explicitly oriented toward life outcomes valued by individuals themselves—could help overcome this siloed perspective by promoting transversal objectives and ensuring that skills such as numeracy are supported not only as academic knowledge but as resources for lifelong adaptation and participation.

CRedit authorship contribution statement

Audrey Vicenzutto: Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization. **Romina Rinaldi:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Maëlle Neveu:** Writing – review & editing, Writing – original draft, Software, Funding acquisition, Formal analysis. **Guillaume Verdure:** Writing – review & editing, Methodology, Data curation, Conceptualization. **Laurent Lefebvre:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT to improve the readability and language of the manuscript. After using it, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Declaration of Competing Interest

All authors contributed to the article conception. They read and approved the final manuscript. The authors declare no conflict of interest. Funding was received from the Marguerite-Marie Delacroix support fund.

Data availability

Data will be made available on request.

References

- American Psychiatric Association. (2013). *American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Washington, DC: American Psychiatric Association.
- Balboni, G., Mumbardó-Adam, C., & Coscarelli, A. (2020). Influence of adaptive behaviour on the quality of life of adults with intellectual and developmental disabilities. *Journal of Applied Research in Intellectual Disabilities*, 33(3), 584–594. <https://doi.org/10.1111/jar.12702>
- Ball, M., Whittington, F., Patterson, V., Hollingsworth, C., King, S., & Combs, B. (2000). Quality of life in assisted living facilities: Viewpoints of residents. *Journal of Applied Gerontology*, 19(3), 304–325.
- Burns, C. O., Lemon, J., Granpeesheh, D., & Dixon, D. R. (2019). Interventions for daily living skills in individuals with intellectual disability: A 50-Year systematic review. In *Advances in Neurodevelopmental Disorders*, 3 pp. 235–245. Springer Science and Business Media B.V. <https://doi.org/10.1007/s41252-019-00114-0>
- Bush, K. L., & Tassé, M. J. (2017). Employment and choice-making for adults with intellectual disability, autism, and Down syndrome. *Research in Developmental Disabilities*, 65, 23–34. <https://doi.org/10.1016/j.ridd.2017.04.004>
- Claes, C., Van Hove, G., Vandeveld, S., van Loon, J., & Schalock, R. (2012). The influence of supports strategies, environmental factors, and client characteristics on quality of life-related personal outcomes. *Research in Developmental Disabilities*, 33(1), 96–103. <https://doi.org/10.1016/j.ridd.2011.08.024>
- Clarke, Barbara, & Faragher, Rhonda (2014). *Educating Learners with Down Syndrome*.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.
- Dusseljee, J. C. E., Rijken, P. M., Cardol, M., Curfs, L. M. G., & Groenewegen, P. P. (2011). Participation in daytime activities among people with mild or moderate intellectual disability. *Journal of Intellectual Disability Research*, 55(1), 4–18. <https://doi.org/10.1111/j.1365-2788.2010.01342.x>
- Edwards, M., & Schippers, A. P. (2024). Expanding the quality of life paradigm: contributions from the field of disability studies. *Journal of Policy and Practice in Intellectual Disabilities*, 21(1), Article e12483. <https://doi.org/10.1111/jppi.12483>
- Faragher, R. (2010). Developing numeracy to enhance quality of life. In *Enhancing the Quality of life of People with Intellectual disabilities*, 401–413. (<http://www.springer.com/series/6548>).
- Faragher, R., & Brown, R. I. (2005). Numeracy for adults with Down syndrome: It's a matter of quality of life. *Journal of Intellectual Disability Research*, 49(10), 761–765. <https://doi.org/10.1111/j.1365-2788.2005.00747.x>
- Faragher, R., & Van Ommen, M. (2017). Conceptualising educational quality of life to understand the school experiences of students with intellectual disability. *Journal of Policy and Practice in Intellectual Disabilities*, 14(1), 39–50. <https://doi.org/10.1111/jppi.12213>
- Felce, D., & Perry, J. (1995). Quality of life: Its definition and measurement. *Research in Developmental Disabilities*, 16(1), 51–74.
- Fortis, A. M., & Luckasson, R. (2011). Reading, writing, and friendship: adult implications of effective literacy instruction for students with intellectual disability. *Research and Practice for Persons with Severe Disabilities*, 36(3–4), 121–125. <https://doi.org/10.2511/027494811800824417>
- Garrels, V. (2019). Student-directed learning of literacy skills for students with intellectual disability. *Journal of Research in Special Educational Needs*, 19(3), 197–206. <https://doi.org/10.1111/1471-3802.12442>
- Gaunt, L. (2022). Numeracy for adults with learning disabilities: A focus on concepts of time. *Education Sciences*, 12(12). <https://doi.org/10.3390/educsci12120868>
- Gaunt, L. V., & Visnovska, J. (2024). Designing specific tools to enhance the numeracy of adults with intellectual disabilities. *Mathematics Education Research Journal*. <https://doi.org/10.1007/s13394-024-00492-2>
- Geiger, V., Goos, M., & Forgasz, H. (2015). A rich interpretation of numeracy for the 21st century: A survey of the state of the field. *ZDM - International Journal on Mathematics Education*, 47(4), 531–548. <https://doi.org/10.1007/s11858-015-0708-1>
- Gómez, L. E., Morán, M. L., Al-Halabi, S., Swerts, C., Verdugo, M.Á., & Schalock, R. L. (2022). Quality of life and the international convention on the rights of persons with disabilities: Consensus indicators for assessment. *Psicothema*, 2(34), 182–191. <https://doi.org/10.7334/psicothema2021.574>
- Jenaro, C., Verdugo, M. A., Caballo, C., Balboni, G., Lachapelle, Y., Otrebski, W., & Schalock, R. L. (2005). Cross-cultural study of person-centred quality of life domains and indicators: A replication. *Journal of Intellectual Disability Research*, 49(10), 734–739. <https://doi.org/10.1111/j.1365-2788.2005.00742.x>
- Jonas, N. (2018). Numeracy practices and numeracy skills among adults. *OECD Education Working Papers*, 177. <https://doi.org/10.1787/8f19fc9f-en>
- LaRue, R. H., Manente, C. J., Dashow, E., & Sloman, K. N. (2016). Functional skills. In N. Singh (Ed.), *Handbook of evidence based practices in intellectual and developmental disabilities* (pp. 169–228). Springer. (<http://www.springer.com/series/11863>).
- Liu, Q., & Wang, L. (2021). t-Test and ANOVA for data with ceiling and/or floor effects. *Behavior Research Methods*, 53(1), 264–277. <https://doi.org/10.3758/s13428-020-01407-2>
- Lowrey, K.A., Douglas, K.H., & Sievers, C.(2011). I Can Identify Saturn but I Can't Brush My Teeth: What Happens When the Curricular Focus for Students with Severe Disabilities Shifts (Vol. 46, Issue 1).
- Lussier-Desrochers, D., Lachapelle, Y., & Caouette, M. (2014). Challenges in the completion of daily living activities in residential settings. *Journal on Developmental Disabilities*, 20, 1.
- McBee, M. (2010). Modeling outcomes with floor or ceiling effects: An introduction to the tobit model. *Gifted Child Quarterly*, 54(4), 314–320. <https://doi.org/10.1177/0016986210379095>
- Moni, K. B., Jobling, A., Morgan, M., & Lloyd, J. (2011). Promoting literacy for adults with intellectual disabilities in a community-based service organisation. *Australian Journal of Adult Learning*, 51(3), 456–478.
- Neveu, M., & Rinaldi, R. (2025). *Maths matter for life: Towards an integrated approach to numeracy for the quality of life of young people with intellectual disabilities*. <https://doi.org/10.3109/13668250.2025.2455569>.
- Novella, E. J. (2010). Mental health care in the aftermath of deinstitutionalization: A retrospective and prospective view. *Health Care Analysis*, 18(3), 222–238. <https://doi.org/10.1007/s10728-009-0138-8>
- OECD (2016). Global competence for an inclusive world. OECD. Available at: <http://globalcitizen.nctu.edu.tw/wp-content/uploads/2016/12/2.-Global-competency-for-an-inclusive-world.pdf> (accessed 20 May 2020).
- Raspa, M., Franco, V., Bishop, E., Wheeler, A. C., Wylie, A., & Bailey, D. B. (2018). A comparison of functional academic and daily living skills in males with fragile x syndrome with and without autism. *Research in Developmental Disabilities*, 78, 1–14. <https://doi.org/10.1016/j.ridd.2018.04.024>

- Rubin, S., Biklen, D., Kasa-Hendrickson, C., Kluth, P., Cardinal, D. N., & Broderick, A. (2001). Independence, participation, and the meaning of intellectual ability. *Disability & Society*, 16(3), 415–429. <https://doi.org/10.1080/09687590120045969>
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemporary educational psychology*, 25(1), 54–67. <https://doi.org/10.1006/ceps.1999.1020>
- Schalock, R. L., Brown, I., Brown, R., Cummins, R. A., Felce, D., Matikka, L., Keith, K. D., & Parmenter, T. (2002a). Conceptualization, measurement, and application of quality of life for persons with intellectual disabilities: Report of an international panel of experts. In *American Association on Mental Retardation*, 40.
- Sparrow, S., Cichetti, D., & Balla, D. A. (2005). *Vineland adaptive behavior scale - 2nd edition manual*. Minneapolis: NCS Pearson inc.
- Tassé, M. J., & Kim, M. (2023). Examining the relationship between adaptive behavior and intelligence. *Behavioral Sciences*, 13(3). <https://doi.org/10.3390/bs13030252>
- Tassé, M. J., Schalock, R. L., Balboni, G., Bersani, H., Borthwick-Duffy, S. A., Spreat, S., Thissen, D., Widaman, K. F., & Zhang, D. (2012). The construct of adaptive behavior: Its conceptualization, measurement, and use in the field of intellectual disability. *American Journal on Intellectual and Developmental Disabilities*, 117(4), 291–303. <https://doi.org/10.1352/1944-7558-117.4.291>
- Tout, D., & Gal, I. (2015). Perspectives on numeracy: Reflections from international assessments. *ZDM - International Journal on Mathematics Education*, 47(4), 691–706. <https://doi.org/10.1007/s11858-015-0672-9>
- Van Loon, J. (2014). Personal outcomes scale. *Encyclopedia of quality of life and well-being research* (pp. 4744–4747). Dordrecht: Springer.
- Verdugo, M. A., Navas, P., Gómez, L. E., & Schalock, R. L. (2012). The concept of quality of life and its role in enhancing human rights in the field of intellectual disability. *Journal of Intellectual Disability Research*, 56(11), 1036–1045. <https://doi.org/10.1111/j.1365-2788.2012.01585.x>
- Wehmer, M. L. (2020). The importance of self-determination to the quality of life of people with intellectual disability: A perspective. *International Journal of Environmental Research and Public Health*, 17(19), 1–7. <https://doi.org/10.3390/ijerph1719121>
- Wehmeyer, M. L. (2003). A functional theory of self-determination: Model overview. *Theory in self-determination: Foundations for Educational Practice*, 182–201.
- Wehmeyer, M. L., & Garner, N. W. (2003). The impact of personal characteristics of people with intellectual and developmental disability on Self-determination and autonomous functioning. *Journal of Applied Research in Intellectual Disabilities*, 16(4), 255–265. <https://doi.org/10.1046/j.1468-3148.2003.00161.x>
- Wehmeyer, M., & Shogren, K. (2016). Self-Determination and choice. In *Handbook of Evidence-Based Practices in Intellectual and Developmental Disabilities* (pp. 561–584). Springer. (<http://www.springer.com/series/11863>).
- Woolf, S., Woolf, C. M., & Oakland, T. (2010). Adaptive behavior among adults with intellectual disabilities and its relationship to community independence. *Intellectual and developmental disabilities*, 48(3). <https://doi.org/10.1352/1944-7558-48.3.209>