

Predictors of numeracy skills giftedness in young children: Perceptions of Botswana early childhood practitioners

Adedoyin, O. O.* and Chisiyanwa, L. A.

BA Isago University, Botswana.

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ABSTRACT

Giftedness in numeracy skills in young children is a phenomenon that is not always visible and easily identifiable. However, these numeracy skills should be recognised in the early years of pre-school education for adequate enrichment on curriculum and pedagogy in teaching young children. Numeracy skills in young children at pre-schools involves the ability to apply mathematical concepts in all areas of life, understanding numbers, counting, solving number problems, measuring, sorting, noticing patterns, adding and subtracting numbers. This study investigated predictors that should be readily visible to notice in pre-school children, who possess giftedness in numeracy skills. In order to establish these predictors, a questionnaire was administered to a random sample of one hundred (100) pre-school teachers from twenty (20) pre-schools in Gaborone. The questionnaire consisted of twenty five (25) items on four Likert scale (Strongly Disagree SD; Disagree D; Agree A; Strongly Agree SA). The pre-school teachers' responses were analysed using factor analysis (available on SPSS Computer package). The principle factor analysis with iteration and varimax rotation method was used to identify the main predictors of giftedness in numeracy skills of young children, and ten (10) factors emerged as predictors of numeracy giftedness in young children, which should have implications on the curriculum and pedagogy in teaching pre-school young children numeracy concepts.

Keywords: Numeracy skills, giftedness, pre-schools.

*Corresponding author. Email: omobola_adedoyin@yahoo.com.

INTRODUCTION

In the past, the concept of giftedness was associated primarily with young children with high intelligence quotient (IQ). Teachers, parents or school administrators always assume that gifted children were born with high intelligence and identified by their high grades and test scores, capable of excelling in all areas of school and of life. These assumptions are still prevalent, although the definition of giftedness in children is beginning to change. Cognitive science, developmental psychology, and new understandings of how learning takes place are influencing the way giftedness is defined and conceptualized.

Giftedness in young children has been explained by

many researchers like Harrison (1999) who defined giftedness in the early years in terms of a child "who performs or has the ability to perform at a level significantly beyond his or her chronologically aged peers and whose unique abilities and characteristics require special provisions and social and emotional support from the family, community and educational context". (p. 20). Harrison (2003:8) defined a gifted child as "one who performs or has the potential to perform at a level significantly beyond his or her age peers and whose unique abilities and characteristics require special provisions and social and emotional support from the family, community and educational context". Harrison

(2003) also explained the concept of giftedness in children as young children with a fast pace of learning, exceptional memory, extended concentration span, ability to understand complex concepts, enhanced observational ability, curiosity, and an advanced sense of humour that is apparent. Most research on giftedness has so far concentrated on intellectual and academic aspects, but according to Clark (2002:25) "gifted children exhibit high intellect and creativity and are frequently accompanied by personality factors that impact the life of gifted children, such as: advanced moral judgment; heightened self-awareness; heightened sensitivity to the expectations and feelings of others; perfectionism; introversion; high expectations of self and others; idealism and a sense of justice; and higher levels of emotional depth and intensity". Horowitz (2004:148) stressed that "giftedness is an interaction between an individual and his or her environment; it is not stable and can change over time".

Giftedness in young children is an advanced abilities, skills and knowledge exhibited in the learning environment. These attributes should be acknowledged and recognised at an early stage to describe young children's intellectual abilities and characteristics. Young children develop numeracy skills at a very early stage in life through everyday play and activities. Numeracy skills in young children at pre-schools involves the ability to apply mathematical concepts in all areas of life, understanding of numbers, counting, solving number problems, measuring, sorting, noticing patterns, adding and subtracting numbers.

Statement of the problem

All early childhood and school professionals have a role to play to mediate and scaffold young children's learning. Early childhood professionals who are not informed and unaware of giftedness and talent in young children, or even rejecting of it, may find they struggle to understand and connect with these children's cognitive, emotional and psychological development. Colangelo and Davis (2003) suggest that lack of appropriate recognition of numeracy giftedness can lead to problems for gifted children, their families and educators. For example, young gifted children who are not extended in their learning can experience boredom, alienation, social difficulties and depression. Some become underachievers, failing to reach their full potential, and develop negative attitudes towards their early childhood setting or school". It is therefore necessary in the 21st century of educational development of young children for pre-school teachers to be able to identify numeracy giftedness in young children which might have implications on the curriculum and pedagogy in teaching pre-school children numeracy concepts. The research objectives for this study are to: identify the predictors of numeracy skills giftedness in young children as perceived

by early childhood practitioners and find out if the qualifications of early childhood practitioners have effect on their perceptions in predicting the concept of numeracy giftedness in young children. This study provided answers to the following research questions: (i) What are the predictors of numeracy giftedness in young children as perceived by early childhood practitioners? (ii) Do the qualifications of these practitioners have effect on their perceptions to predict numeracy giftedness in young children?

Significance of the study

This study is very significant to stakeholders, pre-school teachers, practitioners in Early Childhood Development, parents and Early Childhood Students to enable them identify gifted children in numeracy in pre-schools and provide adequate learning materials, activities for effective learning outcomes. Identification of the predictors of giftedness in numeracy for young children, would have implications on the teaching of pre-school young children.

LITERATURE REVIEW

General concept of giftedness in young children

There are numerous definitions of a gifted child or explanations of the concept on giftedness in young children. Renzulli (2012:20) proposed the three ring conception of giftedness in Figure 1 and emphasized that giftedness in young children can be explained as the child's current level of achievement based on an overlap and interaction among three clusters of traits: above average ability, task commitment, and creativity. Gifted and talented children are those who possess or are capable of developing this composite of traits and applying them to any potentially valuable area of human performance.

Gagné (2004) proposed the differential model of giftedness and talent in Figure 2. He stressed that that the terms 'gifted' and 'talented' are not synonymous and cannot be used interchangeably. According to him, talent is the realisation of a child's giftedness and is enhanced through the intervention of catalysts and other influences. Gagné (2003) suggested that personal characteristics such as motivation and temperament, as well as environment and the interplay between these aspects and innate giftedness, play an important role in the development of talent. Thus, certain traits should be evident in potentially gifted young children, while others are developed through instruction. Gagné (2004) emphasised the impact of the environment and personality in the development of natural abilities (gifts) into specific abilities (talents).

Ziegler (2005) considered giftedness as a characteristic



Figure 1. Three-ring conception of giftedness (Renzulli, 2012:20).

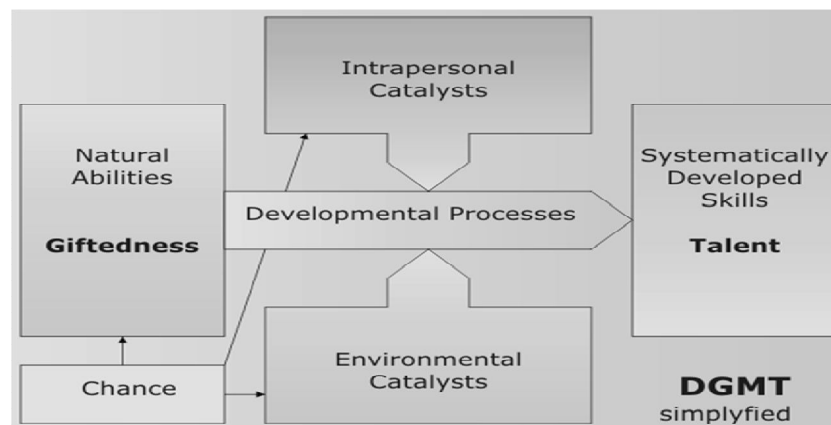


Figure 2. The differential model of giftedness and talent (Gagné, 2003:2).

which changes over time within an environmental context and is the result of various interactions between the individual and the environment (Figure 3). Gifted behaviour is shown, when a person has a wish to do something, the ability to do it and has the awareness that it can be done, and when the environment considers this behaviour as gifted. To attain the action repertoire needed for progressing more excellence years of systematic training are needed. The reactions of the environment in interaction with the determinants in a person have an important influence on the person's perception of the subjective action space.

Because the actions of a person change the environment, the actions needed to be considered as talented, gifted or showing excellence change with the progression of time.

The main elements of Ziegler's (2005), Actiotope Model of Giftedness are:

1. **Actions** consisting of a sequence of partial actions, each of them being a composition of parallel and multiple actions, which require regulation on several levels.
2. The **action repertoire** understood as sustainable

possibilities for action an individual is capable of executing.

3. The **subjective action space**: What people believe they are able to do. (Girls for instance often underestimate their action repertoire.)

4. The **goals**: What people want to do. Every person has several goals, the most important for the gifted are the development of excellence, and the employment of an excellent action repertoire.

5. The **environment** characterized by a rapid alteration of domains.

6. And the **interactions among the components** resulting in a constant quest for equilibrium and progressive adaptation of the individual to the environment and therefore the ability to realize when an action was successful, to recognize when action will be successful, and to generate variations of actions.

Heller and Ziegler (2007), proposed "The Munich Model of Giftedness", used a multifactorial approach to explain giftedness and the development of it. The model was based on four interdependent multifactorial dimensions: talent factors (relatively independent), resulting

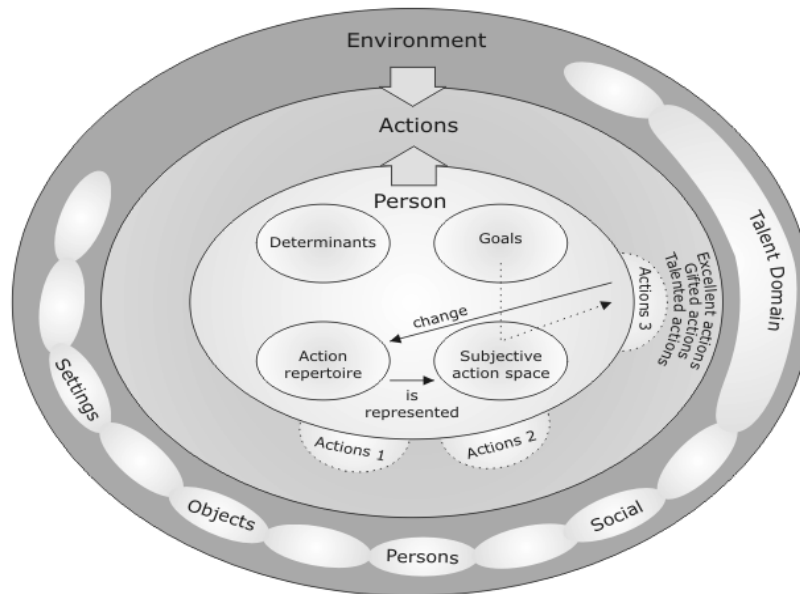


Figure 3. Ziegler's Actiotope model of giftedness (Ziegler, 2005:431).

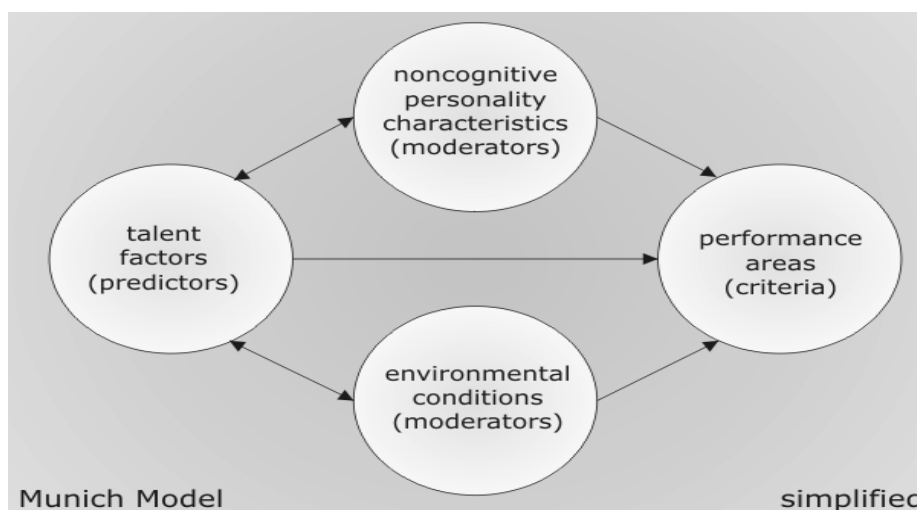


Figure 4. Heller's Munich model of giftedness.

performance areas, personality factors, and environmental factors; the latter two moderating the transition from talent (gifts) to performance.

In the Munich model (Figure 4) the talent factors contain the following seven abilities:

- intellectual abilities,
- creative abilities,
- social competence,
- practical intelligence,
- artistic abilities,
- musicality,
- psycho-motoric skills.

Munich model also mentioned important non-cognitive personality characteristics moderated by the talent factors and moderating talent and performance as:

- coping with stress,
- achievement motivation,
- learning and working strategies,
- control expectations,
- hope for success versus fear of failure,
- thirst for knowledge,
- self-concept.

From recent literature on giftedness, there are two

schools of thoughts on the concepts of giftedness, the developmentalism and essentialism. But the debate between developmentalism and essentialism in terms of conceptions of giftedness that are held today is currently weighted in favour of developmentalism according to the following researchers: Balchin (2009), Horowitz (2004), Kaufman and Sternberg (2008), Reis and Housand (2008) and Sternberg (2000). However, it is still acknowledged by most writers that some tenets of the essentialist view contribute to an overall understanding of giftedness, in much the same way that it has become accepted that nature and nurture work together to influence a child's development.

Research studies on the identification of giftedness

Bicknell (2008) characterized mathematical giftedness through the eyes of parents, students, and teachers. Most of the parents recognized their children's abilities in mathematics at an early age. The parents' descriptions of their children at pre-school age gave an image of what might be seen as innate abilities in these children. The characteristics identified by parents include "impressive concentration" and the ability to work independently for a relatively long period of time on a particular task. Young children no older than 2–3 years were self-initiating games involving numbers and numerical patterns, showing a real fascination for numbers and how they behave in mathematics operations. The types of activities the parents observed in their children at an early age indicated an interest in mathematically driven games, such as: building with construction blocks, creating symmetrical patterns, ordering objects, and completing puzzles and jigsaws in unconventional ways, spending hours of concentration in such activities. Others made connections between ballet movements and angles in geometrical rotations, or have shown a relatively sound concept of number and in some cases an interest in concepts such as time and space.

According to Nolte (2012), not all young potentially gifted children show these signs of mathematical giftedness. In a questionnaire given to more than 100 parents of mathematically gifted students most of the parents' answers support these findings; however, some pointed out that they did not recognize signs of giftedness before their child began school. Moreover, descriptions of mathematical precocity in 2- or 3-year old children should not necessarily lead to the idea that their mathematical abilities were innate. These could have been due to parental and other environmental factors. Once gifted children began school, their level of interest and ability in mathematics compared to their peers became more apparent. The teachers observed in these children the different pace of mathematics learning, an intuitive mathematical knowledge in problem solving, their keen interest in mathematics, the sense of humour and ability

to think in more abstract terms than their age peers, as well as more mental flexibility and a discourse based on logical thinking. Perseverance and excitement with mathematical problems were also observed. Other aspects of mathematics that, according to the students, confirmed their mathematical giftedness include success in competitions; competence with basic mathematical facts; speed of computational skills; problem solving abilities; capacity to work on 'special projects', or on more/different work (than their classmates) to complete independently.

Many authors and research teams developed lists of cognitive characteristics of a gifted child. An example of an age-group-specific list is the one from Käpnick (1998) who investigated primary school children's characteristics of giftedness: remembering mathematical facts; structuring mathematical facts; mathematical sensitivity and mathematical fantasy; transferring mathematical structures; intermodal transfer; and reversing lines of thought. Winkler and Brandl (2016) and Assmus (2016) tested Käpnick's items with second graders and found the following characteristics of mathematical giftedness in early primary school children: ability to memorize mathematical issues by drawing on identified structures, ability to construct and use mathematical structures, ability to switch between modes of representation, ability to reverse lines of thought, ability to capture complex structures and work with them, ability to construct and use mathematical analogies, mathematical sensitivity, and mathematical creativity.

Other indicators of mathematical giftedness according to Stepanek (1999) included the following: unusual curiosity about numbers and mathematical information; ability to understand and rapidly apply mathematical concepts; high ability to identify patterns and to think abstractly; flexibility and creativity in approaching problem solving; ability to transfer mathematical concepts to an unfamiliar situation; persistency and resilience in solving challenging problems.

Sriraman (2005) focused on mathematical processes through which various authors define mathematical giftedness at K-12 level. These processes include, among others, the ability to: abstract, generalize, and discern mathematical structures; manage data; master principles of logical thinking and inference; think analogically and heuristically; visualize problems and/or relations; distinguish between empirical and theoretical principles; think recursive.

MATERIALS AND METHODS

This study used a survey research design to collect opinions of pre-school teachers. In this study, survey research design was to investigate the perceptions of pre-school teachers on the predictors that should be very visible to notice in pre-school children who possess

giftedness in numeracy skills at an early stage in life.

Procedure for collecting data

The researchers employed 5 research assistants who distributed the questionnaires and collected the pre-school teachers' perceptions on the identification of giftedness in numeracy in young children.

The questionnaire was validated using both face and content validity by experts teaching Early Childhood. Cronbach's Alpha was used to find the reliability of the questionnaire, which was 0.873.

Population

The population for this study were all early childhood teachers in one hundred and seven (107) registered pre-schools in Gaborone. In each pre-school, there were about six (6) pre-school teachers. The total population of pre-school teachers used for this study were about six hundred and fifty six (656).

Sample

Out of the one hundred and seven (107) registered pre-schools in Gaborone, a stratified random sampling method based on location of the pre-schools was used to select twenty (20) registered pre-schools in Gaborone. The location was based on the following: pre-schools in Gaborone West; Gaborone North; Gaborone Central and Gaborone South. Five pre-schools were selected by random sampling from each location and a convenience sampling strategy was used to identify five (5) pre-school teachers per school. The total sample size for the study was one hundred (100) pre-school teachers in the four (4) stratified Gaborone locations.

Instrument

The questionnaire consisted of thirty five (35) items on four likert scale (Strongly Disagree SD; Disagree D; Agree A; Strongly Agree SA). Section A consisted of background questions of the respondent. Section B consisted of various attributes of giftedness in young children from literature. The instrument was reviewed by experts for face and content validity. For the reliability analysis, the internal consistency reliability coefficient, Cronbach's Alpha formula was computed for the items in the instrument (the questionnaire) and the value was 0.819.

RESULTS

In Table 1 the pre-school teachers' responses were

analysed using factor analysis (available on SPSS Computer package). The principle factor analysis with iteration and varimax rotation method was used to identify the main predictors of giftedness in numeracy skills of young children. Table 1 shows the total variance explained after factor analysis, with a percentage of 77.631%. After the factor analysis, 10 factors emerged with eigen values greater than 1 as predictors of numeracy giftedness in young children, with the first factor accounting for 12.817% of the total variance. The emerging 10 factors have percentage variance of 12.817; 9.610; 9.072; 7.925; 7.759; 7.277; 6.249; 6.235; 5.722 and 4.965. The idea of rotation is to reduce the number factors on which the variables under investigation have high loadings. New titles were given to the ten (10) emerging predictors of numeracy giftedness in Table 2.

DISCUSSION

1. What are the predictors of numeracy giftedness in young children as perceived by early childhood practitioners in Botswana pre -schools?

Following the factor analysis, 10 factors emerged as predictors of numeracy giftedness in young children as perceived by early childhood practitioners in Botswana pre-schools. They include the following that children exhibit:

- Lots of curiosity in their behaviour.
- An unusual speed of computational skills.
- Good memory on manipulation of numbers.
- A natural understanding of numeracy concepts.
- Creative skills.
- High interest in s numeracy concepts.
- Good mind set in numeracy.
- Outstanding performance in numeracy.
- Passion for numeracy concepts.
- High interest in numeracy concepts to sort out things.

The results from this study are very closely related to findings from earlier studies in different parts of the world, reporting on the identification of giftedness in children.

- i. Stepanek (1999) reported that children perceived to be gifted in numeracy were found to have unusual curiosity about numbers and mathematical information, exhibit a lot of curiosity in their behaviour in class, and among their characteristics was ability to ask probing questions.
- ii. Bicknell (2008) suggested that children gifted in numeracy would have their interest in mathematics become more apparent than their peers and are able to work independently on a particular task.
- iii. Bicknell (2008) and Subotnik et al. (2012) found that children who are gifted in numeracy are able to finish numeracy class work relatively much quicker than their counterparts and seemed to have good memory on

Table 1. Eigen values of the 10 predictors of numeracy giftedness.

Factors	Total	% of Variance	Cumulative %
1.	9.900	28.287	28.287
2.	3.931	11.232	39.518
3.	2.466	7.045	46.563
4.	2.308	6.594	53.158
5.	2.034	5.811	58.968
6.	1.802	5.148	64.116
7.	1.398	3.995	68.111
8.	1.212	3.463	71.574
9.	1.109	3.168	74.742
10.	1.011	2.889	77.631

Table 2. The result of the factor loadings that emerged from the pre-school teachers on the predictors of numeracy giftedness of young children.

Items	Mean	Standard deviation	loadings
Predictor 1: Children exhibit a lot of curiosity in their behaviour			
Item 28: Children asking probing questions in numeracy.	3.53	.991	.759
Item 20: Children that are very confident enough to work independently without teacher guidance in numeracy.	3.80	.980	.741
Item 12: Children very eager to learn numeracy concepts	3.36	1.069	.719
Item 27: Children who are self-critical, but have a positive self- concept.	3.76	1.045	.636
Item10: Children show strong resistance to repetitive activities and memorization.	3.73	1.074	.613
Predictor 2: Children having an unusual speed of computational skills			
Item 7: Children finish classwork quickly in numeracy.	3.38	1.248	.809
Item 1: Children who display unusual academic achievement in numeracy.	3.93	.915	.717
Item 9: Children who learn new numeracy concepts quickly.	3.31	1.041	.626
Item 4: Children retain numeracy information easily.	3.62	1.055	.500
Predictor 3: Children exhibit good memory on manipulation of numbers			
Item33. Children have good memory on manipulation of numbers.	4.07	1.031	.757
Item35. Children with excellent memory to make comparisons based on height, position or size.	4.11	.993	.689
Item 30: Children who enjoy solving problems, especially with numbers and puzzles.	3.80	1.160	.607
Item 31: Children who have the ability to easy understand size, shape and patterns.	4.09	1.041	.573
Item 29: Children who have longer attention span.	3.53	1.191	.549
Predictor 4: Children exhibit a natural understanding of numeracy concepts			
Item 23: Children who do not need extrinsic motivation to perform well in numeracy.	3.47	1.342	.773
Item 22: Children who have intense concentration during numeracy lessons.	3.31	.973	.720
Item6: .	3.42	1.055	.617
Predictor 5: Children exhibit creative skills			
Item 14: Children that are self –motivated when using numeracy skills.	3.76	.908	.814
tem 26: Children very creative with numbers	3.40	1.286	.768
Item 13: Children express unique and original opinions in numeracy.	3.47	.919	.529
Predictor 6: Children exhibit high interest in s numeracy concepts			
Item 18: Children like to argue a lot during numeracy lessons.	2.69	1.125	.738

Table 2. Continues.

Item 16: Children consider unusual approaches to problem solving.	3.33	1.225	.728
Item 21: Children demonstrate strong numeracy skills.	3.62	1.007	.614
Item 15: Children easily make connections in numeracy concepts than others in the classroom.	3.56	1.179	.558
Predictor 7: Children exhibit good mind set in numeracy			
Item 17: Children are very active during numeracy lessons.	4.21	.925	.852
Item 19: Children enjoy playing with skills involving numeracy concepts	4.16	.903	.651
Predictor 8: Children exhibit outstanding performance in numeracy			
Item 5: Children demonstrate strong abilities in numeracy concepts.	3.71	.843	.742
Item 11: Children enjoy challenges during numeracy lesson.	3.56	1.235	.548
Predictor 9: Children exhibit passion for numeracy concepts			
Item 8: Children are very active during numeracy lessons.	3.74	1.065	.786
Item 2: Children are impatient when not called in class to answer questions	3.53	.944	.505
Predictor 10: Children exhibit high interest in numeracy concepts to sort things			
Item 34: Children will have the ability to sort things based on sizes or colour.	4.40	.780	.788
Item 32: Children we have ability to identify more and less of a quantity.	3.82	1.029	.677

manipulation of numbers. That is, gifted children have an unusual speed of computational skills.

iv. Bicknell (2008) and Kapnick (1998) found that children gifted in numeracy tend to be able to create symmetrical patterns, order objects as well remember and structure mathematical facts.

v. Assmus (2016) reported that the children who are gifted, memorize mathematical issues by drawing on identified structures and also capture complex structures and work with them.

vi. Subotnik et al. (2012:3) suggested that “giftedness can be viewed as developmental, in that in the beginning stages, potential is the key variable; in later stages, achievement is the measure of giftedness; and in fully developed talents, eminence is the basis on which this label is granted”.

vii. Gagne (2004) was of the opinion that young children who are gifted exhibit an ease and speed of learning that is not often recognised as giftedness by early years teachers.

viii. Moltzen (2011) suggested that “Gifted children do not realise and reach their potential on their own, these children need stimulating and enriched teaching and guiding, and access to an equitable education should not be a matter of chance”.

ix. Heid (1983) stressed that gifted children are capable of providing answers with an unusual speed and precision. And that their ability in identifying relationships in subjects, concepts and ideas without previous related teaching increases the pace at which they learn.

x. Hettinger and Carr (2003) reported that gifted children are able solve mathematical problems faster. They are

flexible in using different strategies and they are able to select the most suitable strategy for each situation.

2. Do the qualifications of these practitioners have effect on their perceptions?

Table 3 shows Analysis of Variance on the perceptions of practitioners with respect to qualifications. Significant differences as influenced by teacher's qualifications on their perceptions of numeracy gifted were only noted in two variables; (item 18) Children like to argue a lot during numeracy lessons ($p = 0.013$) and (Item 26), Children very creative with numbers ($p = 0.018$).

CONCLUSION

This research study was able to recognise that there exists the concept of giftedness in numeracy concepts exhibited by young children and all early childhood and school professionals have a role to play to mediate and scaffold young children's learning. Early childhood professionals who are not informed and unaware of giftedness and talent in young children, or even rejecting it, may find they struggle to understand and connect with these children's cognitive, emotional and psychological development. Predictors of numeracy skills giftedness in young children as perceived by Botswana Early Childhood practitioners were that children can exhibit any of the following to show their giftedness: *Lots of Curiosity in their behaviour; an unusual speed of computational skills; Children have good memory on manipulation of*

Table 3. Analysis of Variance on the perceptions of practitioners with respect to qualifications.

Items		Sum of Squares	df	Mean square	F	Sig.
Item 18: Children like to argue a lot during numeracy lessons	Between Groups	13.219	4	3.305	3.603	.013
	Within Groups	36.692	40	.917		
	Total	49.911	44			
Item 26: Children very creative with numbers	Between Groups	15.431	4	3.858	3.371	.018
	Within Groups	45.769	40	1.144		
	Total	61.200	44			

numbers; a natural understanding of numeracy concepts; Children have creative skills; High interest in numeracy concepts; Good mind set in numeracy; Outstanding performance in numeracy; Passion for numeracy concepts; High interest in numeracy concepts to sort out things.

From the outcomes of this study, the following recommendations were made as follows:

1. Giftedness in numeracy skills would have implications on the curriculum and pedagogy in teaching pre-school young children. That means development of new curriculum to accommodate for these children.
2. Gifted children should be provided with enriched activities to meet their needs.
3. Workshops organise for pre-school teachers to be able to recognise giftedness in children.
4. Child psychologists should be placed in each pre-school to help in identifying children who are gifted at an early stage.
5. Parents and schools should appreciate children with numeracy skills giftedness.
6. Due to the complexity of giftedness, it should be of great importance that pre-school teachers have specialised preparation in gifted education, namely in identifying and nurturing the gifted children in numeracy.
7. It is critical in the formative learning years that positive dispositions are nurtured, and that secure, safe and stimulating environments allow for all levels of learning for gifted children.
8. It should be made mandatory that all early years teachers engage with the concept of giftedness.

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