

**Exploring the Efficacy of an Applied Diabetes Numeracy Intervention in a
South African Type 1 Diabetic Child Population.**



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DECLARATION

I declare that this research report is my own, unaided work. It is being submitted for the degree of Master of Education (Educational Psychology) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

Meagan Cronin

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June 2012

DEDICATION

This work is dedicated to my parents,

Christopher Cronin and Jennifer Cronin

For their ongoing support throughout my life journey,

My brother,

Callan Cronin

who taught me to never stop enjoying life,

My boyfriend

Hendrik Groenewald

for his unconditional love and

My friend

Tom Sundawo

Who inspired me to do the best I can.

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Abstract

Numeracy skills are vital for a child with diabetes as they need to be able to manage their diabetes effectively, in order to protect one from the complications that come with diabetes. There have been numerous studies that illustrate the poor numeracy skills in children with diabetes. A numeracy intervention specifically related to diabetes was put into place to illustrate whether or not such an intervention is effective in improving a child's diabetic numeracy ability, which will lead to the improvement of diabetes self-management in the future.

A Quantitative quasi-experimental pre-test - post-test non equivalent control group design was conducted to explore the efficacy of an applied numeracy intervention in a South Africa type 1 diabetic child population. The study group comprised of 58 children with type 1 diabetes, each group consisted of 29 participants, and each participant in the experimental group was closely matched according to their level of formal education, grade, age and sex to a research participant in the control group. Both groups were measured before and after the intervention.

The children were between the ages of 8 and 13. All participants were in formal education between Grades 3 and Grade 8. Results revealed that participants in both groups had lower 'functional' grades as compared to their 'actual grade' level which suggests that they performed below their expected grade level. Participants performed better in areas assessing basic mathematical skills than areas which assessed applied diabetes mathematical skills. The intervention was shown to be effective as analyses revealed that there was a highly significant difference ($p < 0.001$) between the Pre and Post Test (applied mathematical sections) of the experimental group which took part in the intervention.

This research is only the starting point for the assessment of the effectiveness of a numeracy component in diabetes related education in South Africa, and through this one would hope that more research in South Africa will be done in this area.

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Chapter 1: Introduction

Type 1 diabetes mellitus is one of the most common chronic diseases of childhood and adolescence today, and it continues to increase worldwide (Northam, Rankins & Cameron, 2006). Type one diabetes has been shown to affect one in five hundred children (Gaudieri, Chen, Greer, Holmes, 2008) Diabetes South Africa (2010) approximates that there are 4-6 million people in South Africa with diabetes of which, 5 – 10% of this population have Type 1 diabetes . The World Health Organisation (2011) believes that the number of people in South Africa with diabetes will triple in the next 15 years.

Chronic illness such as diabetes can affect children and adolescents in many ways, besides the complex treatments that one needs to go through, chronic illness can affect young people's development, their identity, mental health, relationships, education and employment (Sawyer & Aroni, 2005). Children who are diabetic need to learn self-management skills and they need to be able to make lifestyle changes so that they can avoid all the complications that come with diabetes (Semiz, Bilgin, Bundak, Bircan, 2001). It is evident that only a few complications start within the first few months of the onset of diabetes, yet most complications develop only after a few years (Porter & Kaplan, 2008). Diabetes results in the narrowing of the blood vessels (small and large), which results in poor circulation, this together with elevated levels of glucose can cause many complications (Porter & Kaplan, 2008). Poor circulation can cause damage to the heart, lungs, brain, kidneys, nerves and skin, which can result in strokes, heart failure, poor vision, kidney failure, neuropathy, and skin breakdown (Porter & Kaplan, 2008). The better the individual is able to control their glucose levels the better the chance of delaying or preventing these complications (Porter & Kaplan, 2008).

It has also been proven that children with diabetes as with other children who are chronically ill tend to have a worse school attendance history than their healthier peers (Ryan, Vega, & Drash, 1985). Therefore, it could be argued that the more one is able to control and manage their diabetes the better their school attendance will be.

Adequate numeracy skills are of great importance in successful management of diabetes. A child with diabetes needs to learn numeracy skills which is the ability to understand basic mathematical skills, measurement, logic, time, probability and they need to be able to apply these skills to interpret their blood glucose levels, count the carbohydrates that they eat,

follow meal plans as well as administer insulin (Cavanaugh, Huizinga, Wallston, & Gebretsadik, 2008).

A previous study found a deficiency in numeracy skills in children with diabetes attending the Charlotte Maxeke Johannesburg Academic hospital and Chris Hani Baragwanath hospital (Moosa & Segal, 2011)

Therefore it is important for one to explore the efficacy of an applied diabetes numeracy intervention in a South African diabetic Type 1 child population to improve the essential numeracy skills needed to self-manage diabetes.

Chapter 2: Literature Review

2.1.1 Diabetes Type 1

According to Rykheer (1973), “Insulin is the most important catalyst in the metabolism of glucose in the body, a lack of this hormone is responsible for the clinical syndrome known as diabetes mellitus” (p. 394). Diabetes mellitus can be divided into two types: Type 1 (otherwise known as juvenile diabetes or insulin dependent diabetes) usually begins early in life, and Type 2 (otherwise known as maturity-onset diabetes or non insulin dependent diabetes) usually begins later on in life (Guyton, 1981). In Type 1 diabetes, there is a deficiency of insulin (Porter & Kaplan, 2008).

It has been found that in Type 1 diabetes the body tends to turn on itself and destroy all the insulin producing cells in the body. Insulin, which is produced by the pancreas is responsible for the amount of glucose in the blood, and is mostly secreted during meal times, especially in response to eating carbohydrates (Segal et al., 2009). In order for the body to function effectively, the carbohydrate/snacks that one eats is broken up into glucose (Porter & Kaplan, 2008). Once the glucose is absorbed into the bloodstream, insulin is secreted, its main function is to move the glucose from the blood into the cells, and there it's converted into energy or stored for later when you are not eating (Segal et al., 2009; Porter & Kaplan, 2008). The level of glucose that an individual has in their blood varies throughout the day depending on the amount and the type of food one eats (Porter & Kaplan, 2008). In between meal times the balance between insulin which lowers the glucose and glucagon which raises the glucose determines the steady state glucose level. A deficiency of “basal” insulin will contribute to high glucose levels. Most cells in the body require insulin to utilize glucose, however, the brain is dependent on a positive diffusion gradient to deliver vital glucose (the brains primary fuel source). The brain is therefore sensitive to both high and low glucose levels (Dr. D. Segal, personal communication, November 13, 2011).

Maintaining blood glucose levels as close to normal (3.0 to 8.0 mmol/l) can delay or prevent the devastating long-term complications of diabetes. This has aptly been proven in the Diabetes Control and Complication Trial (DCCT) (1996). In this trial the average blood glucose level was estimated by measuring the Haemoglobin A1C (HbA1c) levels. Long-term micro vascular complications increased non-linearly with increasing HbA1c levels. When assessing Glycosylated HbA1c levels a normal level is less than 5.6%, diabetes patients

rarely reach such levels. Levels above 9 % indicate poor control and levels above 12% indicate even poorer control. Most diabetics are required to check these levels every 3 to 6 months (MedicineNet, 2004) Additional evidence suggests that it is not only the average blood glucose level that contributes to complications, but also the within day fluctuation.

A limiting factor in diabetes management is the development of hypoglycaemia. According to the DCCT trial as cited in Musen et al., 2008, p.1943 severe episodes of hypoglycaemia, defined as, “any event requiring the assistance of another individual, including seizure or coma, with either blood glucose <2.78mmol/l and/or subsequent reversal of symptoms with oral carbohydrate, glucagon injection, or intravenous glucose.” were 3 times more common in the intensively managed group with the lowest HbA1c.

2.1.2 Impact of diabetes on cognitive functioning

There is a definite relationship between cognitive deficits and type 1 diabetes (Brands et al., 2005). The etiology of which can be apportioned to both hypoglycaemia and hyperglycaemia.

Chronic hyperglycaemia is the norm in diabetic patients interspersed with brief episodes of hypoglycaemia ranging from mild to severe. The long-term implications of these fluctuations are known to cause neuro-cognitive deficits (Northam et al., 2006; Brands, Biessels, Haan, Kappelle, & Kessels, 2005; Ryan et al., 1985).

In the short term hypoglycaemia can result in transient but scholastically important impairment in concentration and memory processing (Northam, et al., 2006). Acute severe hypoglycaemic episodes particularly when accompanied by coma and seizures can cause permanent brain damage and even death.

Acute and transient episodes of hyperglycaemia impair concentration and memory too, while there is increasing evidence to suggest that chronic hyperglycaemia, particularly in a developing brain can cause permanent neurocognitive impairment (Brands et al., 2005).

Children are more sensitive to glucose deprivation, as they have higher cerebral energy needs due to brain growth (Northam et al., 2006). In supporting this statement Ltief and Schwenk (1999) retrospectively reviewed the medical records of 59 children with type 1 diabetes and it was found that severe hypoglycaemic reactions were more common in infants (55%) and

children between the ages of 2 and 5 (45%), when compared to children from the ages of 5 to 9 (13%).

There is a body of research which has explored the relationship between the age of onset of diabetes (before the age of 5 when the brain is still developing) and the affects it has on neurological functioning. It has been found that the age of onset of diabetes (before age 5), as well as the amount of time that one has had diabetes seems to negatively affect neuropsychological functioning in many different ways (Ryan et al., 1985). Northam et al. (2006) posited that early onset of diabetes was one of the most consistent risk factors for neurocognitive damage and deficits in cognitive functioning have been detected as early as 2 years after the diagnosis of type 1 diabetes in children (Kodl & Seaquist, 2009).

The neuropsychological profiles of children 6 years after they had been diagnosed with diabetes type 1 were conducted, and it was found that the attention, processing speed, and executive skills were most affected in children when the onset of the disease was before the age of 4 years (Northam et al., 2001). Furthermore, Ack, Miller and Weil (1961), assessed the intelligence levels of children with diabetes and the results indicated that children who had an onset of diabetes before the age of 5 had significantly lower IQ's when compared to their non-diabetic siblings. Ryan et al. (1985) found that those with early-onset diabetes scored significantly lower in neuropsychological tests than those who developed the disease after 5 years, than individuals who were not diabetic yet came from the same demographic backgrounds.

Possible explanations for the neurocognitive deficits in younger patients include the greater frequency of severe hypoglycaemic reactions, a longer period of exposure to dysglycaemia due to their early diagnosis and a heightened sensitivity of the developing brain to metabolic insults induced by both hyper and hypoglycaemia (Northam et al., 2006; Ryan, 2006; Ternard, Go, Gerich, Morey, & Haymond, 1982, as cited in Ryan et al, 1985).

According to Ryan et al. (1985), the age at onset of diabetes tends to affect performance on a set of tests that are regarded as measuring primarily “right hemisphere functioning”, whereas the duration of diabetes normally affects the scores of tests that measure “left hemisphere functioning.” Therefore the age at onset reflects “fluid intelligence”, and the duration of diabetes affects “crystallized intelligence” (Ryan et al., 1985).

When looking at acute episodes of hypoglycaemia research indicates that adults experience cognitive deterioration when the blood glucose levels drop to 2.5 mmol/l whereas children develop cognitive deterioration when their blood glucose levels fall below 3.3 mmol/l (Musen et al., 2008).

Recently research has focused on how acute episodes of hypoglycaemia effect the neurocognitive functioning of children as well as their academic achievement (Northam et al., 2006) It has been found that memory, language, attention and executive functions are the areas in children that are most affected by diabetes. This often goes unnoticed, and children with diabetes don't get the extra assistance that they may need (Northam et al., 2006) A child with diabetes may also experience acute episodes of mild hypoglycaemia while in the classroom; this will affect a child's ability to learn, and will over time result in scholastic underachievement (Northam et al., 2006). Acute hypoglycaemia can lead to comas, accidents, and injuries. It is also clear that if a severe hypoglycaemic episode occurs for a long period of time, brain damage can occur.

2.1.3 Literacy and Numeracy skills

According to the Ad Hoc Committee on Health Literacy (1999), literacy is the ability to read, write as well as the ability to speak a specific language, one also needs to be able to solve problems at appropriate levels of proficiency that is needed to function in society effectively, to achieve one's goals and develop to one's full potential. Low health literacy is very common with patients who have diabetes, and it has been found that these patients have a decreased understanding of their disease and in the end, worse clinical outcomes (Rothman et al., 2009). In a study conducted by Baker, Parker, Williams, and Clark (1998) it was found that 55% of the patients in two urban public hospitals had inadequate literacy skills. Of these patients 50% were not aware of the symptoms of hypoglycaemia, 62% didn't know how to treat a hypoglycaemic episode, 42% did not know the normal blood glucose range, and 73% of these individuals have attended diabetes education classes (Baker et al, 1998).

Numeracy is seen as an important component of literacy (Rothman et al, 2006). Numeracy does not only relate to basic mathematical skills such as calculations, fractions, algebra, and arithmetic, it is also one's ability to understand measurement, logic, time, graphs, hierarchies, and probability (Huizinga et al., 2008). It is also the ability to understand numbers, and be able to use them effectively in one's day to day life (Rothman et al., 2006).

Even though numeracy and literacy are related Rothman et al. (2006), have found that many patients that have health literacy skills, lack the basic numeracy skills that are required for effective diabetic management, and furthermore, patients with poor numeracy skills are more likely to have hypoglycaemic episodes (Rothman et al., 2009).

The Diabetes Numeracy Test (DNT) is a tool, the only one available, which has been utilized to measure a wide range of applied numeracy skills that are important to the daily life of a diabetic patient (Cavanaugh et al., 2008). It was developed by a panel of experts at Vanderbilt University (Huizinga et al., 2008). The DNT contains 43 items and has an excellent internal reliability (determined by the Kuder-Richardson coefficient-20 = 0.95) as well as construct validity (Huizinga et al., 2008). It tests five domains: Nutrition, Exercise, Blood glucose monitoring, Oral medication and Insulin (Rothman et al., 2009). However, the test was originally developed for adults and no specific test had been developed to measure numeracy skills in children. The need for a questionnaire led Moosa and Segal (2011) to develop the Diabetes Mathematical Questionnaire (DMQ) that could measure the math numeracy skills of South African children. Their DMQ has been based on the Tirisano Revised National Curriculum Scale which means that all the questions have been developed according to South African educational standards. The same questionnaire was utilized to explore the efficacy of an applied numeracy intervention in a South African type 1 diabetic child population.

2.1.4 Diabetes and numeracy and self-management

The concept of self-management is based on the idea that, if done correctly, it will improve the well-being of individuals, strengthen their self-determination and their participation in health care, and at the same time reduce health care costs (Sawyer & Aroni, 2005). It is important that an individual with diabetes assume responsibility for regulating their blood glucose levels (Hampson et al., 2001). As mentioned earlier, adequate numeracy skills are crucial in the management of many chronic diseases, one being diabetes. Numeracy skills are needed to be able to interpret blood glucose levels, follow dietary guidelines, count carbohydrates as well as administer medication (Cavanaugh et al., 2008; Huizinga et al., 2008). Individuals with diabetes have to be able to calculate the amount of carbohydrates that they are eating, so that they can adjust their insulin levels accordingly. If one struggles with numeracy skills suboptimal glycemic control will occur, and more hypo and hyperglycaemic episodes will take place (Huizinga et al., 2008). Adolescents and young children who have

diabetes type 1 need to administer exogenous insulin as well as monitor their blood glucose levels on a daily basis, to avoid long-term complications of diabetes mellitus (Northam et al., 2006). It has been found that deterioration in metabolic control often occurs during early adolescence (Anderson, Wolf, Burkhardt, Cornell, & Bacon, 1989).

Cavanaugh et al. (2008) explored the relationship between diabetes-related numeracy and perceived self-efficacy, self-management activities, as well as clinical measures in diabetic patients. They collected demographic, as well as clinical information about patients with diabetes. To do this they conducted interviews and reviewed medical records. They looked at individual's self-management behaviours, their most recent haemoglobin A1c level, and their use of insulin (Cavanaugh et al., 2008). They used the Rapid Estimate of Adult Literacy in Medicine (REALM) to assess the literacy of the patients, the Wide Range Achievement Test, 3rd edition (WRAT-3) to measure their calculation skills, and the DNT to measure the diabetes-related numeracy skills (Cavanaugh et al., 2008). In their study it was shown that those individuals who scored low on the literacy and numeracy skills seemed to answer the numeracy skills related to diabetes incorrectly (Cavanaugh et al., 2008). Only 44% of patients could work out the amount of carbohydrates in a snack-size bag of potato chips correctly, and only 41% of patients could calculate the insulin dose that required adjustment correctly. They discovered that only 1 in 4 patients were able to determine what values were within the normal blood glucose range, this skill is of great importance when it comes to monitoring one's blood glucose level (Cavanaugh et al., 2008). The results of the study indicated that in younger patients, those who achieved low DNT scores had higher haemoglobin A1c levels than those who scored higher, which suggests that low diabetes-related numeracy is associated with poorer glycemic control (Cavanaugh et al., 2008). They found, as with many other studies, that there was very little correlation between literacy and haemoglobin A1c (Osborn, Cavanaugh, Wallston, White, & Rothman, 2009). This may be due to the fact that diabetes-related numeracy skills are more associated with haemoglobin A1c than literacy and numeracy, as they are linked more to diabetes self-management activities (Cavanaugh et al., 2008). A very similar study was done with African American adults with diabetes, where the same measurement tools were utilised to determine if literacy, basic numeracy, and diabetes-related numeracy could explain the association between these individuals with diabetes and poor glycemic control in patients with diabetes (Osborn et al., 2009). Osborn et al. (2009) found that only diabetes-related numeracy could significantly predict one's A1c levels, with regards to a sample of African American adults with diabetes.

Low diabetes-numeracy skills could be due to factors such as socio-economic status, life opportunities that one has been given, and education (Osborn et al., 2009). It was found in the study done by Cavanaugh et al. (2008) that most of those who scored low in the diabetes numeracy skills test, and who seemed to be more at risk for bad glycemic control, were young, non-white, newly diagnosed, had poor literacy and numeracy skills, and had low educational levels. It was recommended by Cavanaugh et al. (2008) that patients with diabetes would benefit from better diabetes education, especially if numeracy-focused materials could be utilized to make the application of health information easier to understand. The development of educational programs and tools that are tailored to a patient's individual needs would benefit individuals with diabetes (Wolff et al., 2009; Ryan, 2006). Tools that accommodate those who don't have effective numeracy skills would be very useful in improving self-management skills, as well as glycemic control, and further research on the numeracy-focused interventions would be beneficial to improving care in patients with diabetes (Cavanaugh et al., 2008).

2.1.5 Diabetes and numeracy skills in the South African Context

According to Wild, Roglic, Green, Sicree, & King (2004), there is an increase in diabetes in Africa, and the epidemic will continue to grow. As previously mentioned Diabetes South Africa (2010) approximates that there are 4-6 million people in South Africa with diabetes of which, 5 – 10% of this population have Type 1 diabetes today. Interestingly, however, knowing this not much research on diabetes and numeracy skills in the South Africa context has been conducted.

Only one study on the math literacy skills in type 1 children as well as their caregivers was carried out in South Africa, by Moosa and Segal (2011). The sample population was taken from paediatric clinics at the Chris Baragwaneth and Charlotte-Maxeke Johannesburg Academic Hospital. The study entailed a face-to face interview, as well as a questionnaire which assessed the basic level of mathematics skills, and continued to assess numeracy skills related to diabetes (Moosa & Segal, 2011). As the DNT had only been developed for adults a new questionnaire had to be developed to fit the South African context and one that would be able to assess diabetes numeracy skills in children with diabetes (Moosa & Segal, 2011). The DMQ that was developed was based on the DNT and was compiled according to the requirements of the Tirisano Revised South African National Curriculum Statement (RNCS).

The questionnaire is subdivided into two sections, with Section 1 testing basic mathematical skills such as addition, subtraction, multiplication, division, fractions, estimation, matching, and sequencing. Section 2 tests applied mathematical skills and consists of grade-appropriate numerical tasks designed around diabetes related scenarios that assess the use of the 'basic' mathematical skills in day to day diabetes management (Moosa & Segal, 2011).

The results showed that 53% of the children that took part in the study underperformed, which indicates that they had inadequate basic maths skills for their current grade (Moosa & Segal, 2011). These individuals scored even lower when it came to the diabetic related tasks, and their HbA1c levels were also high. The researchers recommended that the development of educational programs for diabetic patients with lower literacy and numeracy skills that incorporate numeracy training and the efficacy of the interventions need to be put in place .

2.1.6 Therapeutic Recreation Camps and Educational Workshops

Not much research has been done on the efficacy of workshop and camp programmes with children who have a chronic disease (Walker & Pearman, 2009). Summer camps or day programmes for children with chronic illness in the past have included fun recreational activities, such as crafts, sports, and camp fires, and may include discussions focused on their illness (Plante, Lobato, & Engel, 2001). Several studies have assessed the impact of camps on children with chronic illnesses. It has been found that the evaluation of the effectiveness at diabetic camps has been based on self-management and symptom control, in which there have been very mixed results. Camping and youth support programmes are designed to help improve the quality of life for an individual living with diabetes, and their psychological well-being (Semiz et al., 2001). According to Semiz et al. (2001), a camp setting is seen as the ideal place to teach adolescents the necessary skills for effectively managing their diabetes. It has been found that interventions in therapeutic recreation camps improve self-esteem, knowledge of a disease, adaptation to the disease, as well as ones emotional well-being, and that young individuals are the ones that benefit most from these camps (Walker & Pearman, 2009).

Semiz et al. (2001), explored the effectiveness of summer camps for diabetic children in Turkey. They looked at the camps from 1999 to 2000 and it was found that there was a significant improvement in both the knowledge and the self-management of the disease by the time the camp had ended, yet no changes in HbA1c levels were observed, which indicates

that the improvements were not long-standing. Therefore, the long-lasting improvements have not yet been determined. Semiz et al. (2001), still maintain that camps for children with diabetes are invaluable.

Pre-post evaluations have indicated that individuals who go camping do gain knowledge on their disease, and there are improvements with regards to their self-esteem, attitudes, as well as management of diabetes (Plante et al., 2001). An area of concern is that no controlled studies of camps have been done specifically for children with diabetes (Plante et al., 2001).

2.1.6 Group interventions

Group interventions for children have been implemented in order to increase the knowledge of an illness, to increase the way in which they psychologically adapt to the illness, and to decrease symptoms and side effects that come with a disease (Plante et al., 2001). Peer support has been highly rated by young individuals with chronic illness. Individuals that come together with the same chronic illness tend to be of benefit to each other, as they have many things in common and share the same problems (Sawyer & Aroni, 2005).

Psychoeducational groups are there to improve psychological adjustment to illness by providing important information about diabetes, and how it can be effectively managed (Plante et al., 2001). There is controversy regarding psychoeducational groups as indicated in the study done by Kaplan, Chadwick and Schimmel (1985), where 21 adolescents were randomly assigned to a psychoeducational or a social learning group for three weeks. There was a slight increase in pre-post blood glucose for those who partook in the psychoeducational group and a slight decrease in pre-post HbA1c levels in the social learning group. Therefore, psychoeducational groups may improve attitudes, but according to Plante et al. (2001), they don't improve the symptoms.

Many skills development groups have been implemented, the aim of which is to enhance specified skills related to diabetes (Plante et al., 2001). Plante et al., 2001 assessed the effectiveness of skilled development groups in 14 studies. It was found that programs that specifically target coping and management skills have shown to improve physical symptoms and psychosocial functioning in both children and adolescents (Plante et al., 2001).

Anderson et al. (1989) randomly assigned young adolescents with IDDM to an intervention that was based on problem solving with the self-monitoring of blood glucose levels for the

period of 18 months. When a follow-up was done it was found that 50% of those who had standard care exhibited more than a 1% increase in HbA1 levels, whereas only 23% of those who had an intervention had an increase in glycoslated haemoglobin levels (Anderson et al., 1989). Therefore it can be said that problem solving groups are effective with young adolescents who have IDDM in preventing the deterioration in blood glucose (Anderson et al., 1989). Group interventions seem to impact glucose levels. In a study done by Maxwell, Hunt, and Bush (1992), individuals with diabetes were randomly assigned to two different groups, the control group was provided with a training program only, whereas the experimental group received both the program and 8 support group meetings. After 7 months a follow-up study was done and it was found that both the control and experimental groups improved in both metabolic control and diabetes knowledge. Qualitatively it was discovered that most of the individuals experienced positive feelings in the support groups that they participated in.

According to the GOLD Peer Education Development Agency South Africa (2010) there is also a need for peer education, which is where a group of skilled facilitators help a group of suitable young people to informally role-model positive behaviour, to educate their peers in a structured manner, recognise those who need extra help and refer where necessary, and uplift individuals through awareness and advocacy. By working with peers one is allowed an opportunity for modelling, problem solving as well as helping each other (Plante et al., 2001).

One must be aware that even though self-management education is important for any patient with diabetes, those individuals with low health literacy and numeracy skills may find it very difficult to put the information that is learned into effective self-care (Wolff et al., 2009).

A review was done on all the group interventions for paediatric chronic conditions and it was concluded that, although they do exist, more needs to be done in regards to the efficacy of the interventions put in place (Plante et al., 2001).

2.1.7 Mathematical interventions for patients with diabetes

No research that specifically focuses on teaching basic mathematical concepts to diabetic patients can be found. Vanderbilt University has designed a diabetes literacy and numeracy toolkit that has been designed to help educate diabetic patients with self-management (Rothman et al., 2009). It was designed by a multidisciplinary team which included diabetes

educators, experts on health literacy and numeracy, dieticians, nurses, pharmacist, and educational psychologists who provided the instruction in which it should be given (White, Wolff, Cavanaugh, & Rothman, 2010). It has been divided up into the following modules: Introduction, Testing one's blood sugar, an Exercise plan, Examining one's feet, Introduction to eating with diabetes, Applying carbohydrates, Counting carbohydrates, Fixed dose carbohydrates using scoops, Applying carbohydrates, and Insulin usage (Rothman et al., 2009). Most health educational material has been written for a 9th grade level whereas this toolkit has been designed for a lower grade, making it easier for younger patients to understand (Wolff et al., 2009). Although this toolkit helps individuals with low numeracy skills learn self-management skills, it does not specifically teach basic and diabetes numeracy skills that are found to be lacking.

A meta-analysis of 58 studies on mathematical interventions for children with special needs on an elementary level was done (Kroesbergen & Luit, 2003). Interventions that covered three different areas were selected: preparatory mathematics, basic skills, and problem solving strategies (Kroesbergen & Luit, 2003). Most of the studies looked at the basic skills, and it was found that these interventions were also seen as the most effective (Kroesbergen & Luit, 2003). The duration of the specific interventions, as well as the method, was of importance to the results. It was also found that mediated instruction was not as effective as direct instruction and self-instruction (Kroesbergen & Luit, 2003).

By looking at all the related research conducted in the past, it is evident that further exploration in the area of diabetes numeracy education in the diabetic Type 1 South African child population is needed.

Chapter 3: Methodology

3.1 Research Aims

This research aims to explore the efficacy of an applied diabetes numeracy intervention in a camp setting in a South African diabetic Type 1 child population to improve the essential numeracy skills needed to self-manage diabetes.

3.2 Rationale

According to the World Diabetes Foundation (2010), there has been an explosion of diabetes worldwide. As mentioned before there are approximately 4-6 million people in South Africa with diabetes, of which 5-10 % of this population have Type 1 diabetes today (Diabetes South Africa, 2010) and this number will triple in the next fifteen years (World Health Organisation, 2011). Diabetes type 1 is prevalent amongst children and adolescents and it is a disease that affects all areas of a child's life. Numeracy skills are vital for a child with diabetes as they need to be able to manage their diabetes effectively, in order to protect one from the complications that come with diabetes (Semiz et al., 2001). As previously stated by Cavanaugh et al. (2008) and Huizinga et al. (2008), a child with diabetes needs to learn numeracy skills and apply these skills to be able to count their carbohydrates, interpret their blood glucose levels, follow specific meal plans as well as be able to administer insulin at the correct time. In earlier discussion it is evident that glycemic control plays a vital role in cognitive performance with type 1 diabetic patients, and it has been found that areas such as memory, attention, motor speed, psychomotor efficiency, verbal IQ's and academic achievement do improve with better glycemic control (Kodl & Seaquist, 2009).

There have been numerous studies that illustrate the poor numeracy skills in children with diabetes, yet a numeracy intervention specifically related to diabetes to see whether there is an improvement in a child's diabetic numeracy ability, has never been put into place on an international scale or in South Africa. Research in this field might illustrate whether diabetic numeracy interventions are effective in improving a child's diabetic numeracy ability which will lead to the improvement of diabetes self-management, which may then help minimize hypo and hyperglycaemia in children. It could also have a positive effect on an individual's

school achievement, as the more diabetes is managed the less sick days a child will have, and the better they are likely to perform at school (Ryan et al., 1985).

There is a huge gap with regards to research in this topic, therefore it is crucial to explore whether or not a weekend long numeracy intervention was effective so that more diabetes numeracy interventions can be put into place to help children manage their diabetes more effectively in the future. No studies on the effectiveness of applied diabetes numeracy interventions in the South African context have been undertaken.

3.3 Definitions

3.3.1 Level of education - ‘actual’ grade and ‘functional’ grade

The actual grade according to Moosa and Segal (2011) is the current grade or highest level of education that has been achieved. The Functional grade according to Moosa and Segal (2011) is the grade that was achieved on testing. The difference between the two was analyzed in this present research study. The functional grade was the maximum grade achieved by completing each section and achieving a score of 50% or more in each section. The testing sections were also analyzed according to each competency skill for example addition, multiplication, division, subtraction, estimation, sequencing, averaging, data interpretation, fractions and time.

3.3.2 The Revised National Curriculum Statement (RNCS)

The Diabetes mathematical Questionnaire (DMQ) which was devised by Dr. Fatima Moosa and Dr. David Segal was based on the Tirisano Revised National Curriculum Statement (RNCS). The implementation plan for the Tirisano (which means ‘working together’) was launched in 2000 and the key objectives identified that apply to this present study covered areas such as school effectiveness, literacy and was aimed at improving the system of education and the quality of teaching (Chisholm, 2004). There are eight different learning areas in the National Curriculum Statement. These are: Languages, Mathematics, Natural Sciences, Technology, Social Sciences, Arts and Culture, Life Orientation, Economic and Management Services (Department of Education, 2002). The Learning Area Statements provide guidelines and expectations from Grade R to Grade 9 (Department of Education, 2002). The DMQ (Section 1) was based on the above.

3.3.3 Schooling in South Africa

According to the Department of Education there are three different types of schools: No-fee schools, Fee-paying schools and Private (Independent) schools. The *South African Schools Act* (SASA) of 1996 established a national schooling system and two categories of schools were identified: public and independent. Public schools (Fee and no-fee paying) are state controlled and independent schools are privately governed (Department of Education, 1998). The Department of Education assesses each school literacy rates, their surrounding community, and their income levels; they are then given a poverty ranking (Hall & Monson, 2006). The no-fee schools policy takes away school fees in the poorest 40% of schools that consist of learners from grade-R to grade 9 (Hall & Monson, 2006).

3.4 Research Questions

1. At what level are the participant's numeracy skills prior to the diabetes numeracy intervention?
2. At what level are the participant's diabetes numeracy skills prior to the diabetes numeracy intervention?
3. Is there a difference in their diabetes numeracy skills after the intervention has taken place?
4. Is there a difference between the control and experimental group's numeracy skills at both the pre and post-test?
5. Which areas of numeracy (if any) were not affected by the intervention?

3.5 Research Design

A Quantitative quasi-experimental pre-test - post-test non equivalent control group design was conducted to explore the efficacy of an applied numeracy intervention in a South Africa type 1 diabetic child population. An experimental and control group were formed. Both groups were measured before, only the experimental group took part in the intervention and again both were measured after the intervention took place. The pre-test measures allowed for the researcher to address the problem of assignment bias that exists with all non-equivalent groups, therefore the researcher was able to compare if the groups were matched correctly. It

was important to match the experimental and control groups individually so that a more powerful paired sample T-test could be performed in the analysis of the results. The researcher also compared the pre-test and post-test scores to determine whether the numeracy intervention was effective or not.

The independent variable in this study was the numeracy intervention and the dependant variable was the scoring of the Diabetic Numeracy Questionnaire (Moosa & Segal, 2011).

3.6 Ethics Clearance

Ethics clearance was obtained from the Human Research and Ethics Committee of the University of the Witwatersrand, clearance number M110221. (Appendix A)

3.7 Place where the research was conducted

3.7.1 Experimental Group

The research took place at Camp Nelu which is a Camp which specialises in educating children with diabetes mellitus. A successful multidisciplinary diabetes program has already been running from Camp Nelu since 2005, initiated and managed by Dr. David Segal, a specialist in diabetes care, and his team. School children with diabetes from the Gauteng region are able to attend the camps to learn self-care skills and return to their school with knowledge of how to manage diabetes on a day to day basis. The campsite is found at the foot of the Magaliesburg mountain range in Hekpoort. These camps are run professionally under safety standards recognised overseas to ensure a fun, smooth and safe camp. There are always Doctors, Diabetes Specialist Nurse's, Diabetes Educators and well trained Diabetes Youth Leaders at the campsite.

3.7.2 Control Group

The research took place at Dr Segal's (paediatric endocrinologist) offices which are located on 18 Eaton road, Parktown (Wits Medical Centre). It was completed over a different weekend from the intervention but was done within the same time-frame as the experimental

group. After the research took place the control group were offered to take part in the next group intervention at Camp Nelu.

3.8 Sample

The target population were children that were in Grade 3 to Grade 7 from the Gauteng region that have been previously diagnosed with Diabetes Mellitus Type 1 by a Paediatric Endocrinologist. The experimental group consisted of a sample of 29 who were selected from the group of diabetic children who chose to attend Camp Nelu. Any child that has been diagnosed with diabetes for any period of time can select to attend this camp on a yearly basis. Most of the individuals that attend the camp are Dr. David Segal's patients from the Johannesburg General Hospital as well as his private practice.

The control group consisted of children in the same grades (Grade 3 to Grade 7) that did not take part in the camp, out of choice. They were selected from a diabetes data base at Dr. David Segal's offices and were contacted individually. The individuals selected for the control group were individually matched to the experimental participants according to their grade, schooling, and sex so that a more powerful paired-sample T-test could be performed when analysing the data.

3.9 Sampling method

A convenience non-probability sample method was utilized to select the experimental as well as the control group (Gravetter & Forzano, 2006). This form of sampling is where the selection of participants is not determined by randomness and they have either volunteered, or been selected as they fit the criteria for the research (Terre Blanche, Durrheim, & Painter, 2006).

The individuals who were selected for the experimental group voluntarily attended the camp where the intervention took place, and they were utilised for the research study as they fitted the criteria for the research.

The individuals selected for the control group were individually matched to the experimental participants so that a more powerful paired-sample T-test could be performed.

3.10 Instruments

This study utilized a questionnaire to obtain the data. The Diabetes Mathematical Questionnaire (DMQ) (Appendix B) which was developed by Dr. Fatima Moosa and Dr. David Segal is based on the Diabetes Numeracy Test (DNT) which was developed by a panel of experts at Vanderbilt University (Huizinga, 2008) was utilized in this present study. The DNT contains 43 items and has an excellent internal reliability (determined by the Kuder-Richardson coefficient-20 = 0.95). The DNT was significantly correlated ($p < 0.05$) with education, income, literacy and math skills, and diabetes knowledge which supports that it has excellent construct validity (Huizinga et al., 2008).

The DMQ that was developed by Dr. Fatima Moosa and Dr. David Segal (2011) was compiled with the requirements of the Tirisano Revised South African National Curriculum Statement (RNCS). The questionnaire is subdivided into two sections: Section 1 tests basic mathematical skills such as addition, subtraction, multiplication, division, fractions, estimation, matching and sequencing, whereas section 2 tests applied mathematical skills and consists of grade appropriate numerical tasks designed around diabetes related scenarios that assess the use of 'basic' mathematical skills in day to day diabetes management. A good correlation was found between the percentage scores of the basic mathematical skills (Section 1) and the applied mathematical skills (Section 2) respectively, implying that the applied skills questions were appropriately levelled to the basic skills section questions. This was found with regards to the children's group ($r = 0.81$, $p < 0.0001$). The estimated time to complete the Questionnaire is about 30 minutes (Moosa & Segal, 2011).

For the present study a Cronbach Coefficient Alpha was done to assess the reliability of the different sections in the questionnaire. Section 1 ($r = 0.98$), Section 2 (Pre-Test) ($r = 0.91$) as well as Section 2 (Post test) ($r = 0.89$) can be seen as reliable which means that the questionnaire is consistent in measuring the numerical ability of the research participants.

3.10.1 Questionnaire data

According to Moosa and Segal (2011) the DMQ utilised for the study is divided up as follows:

- Demographic details (age, sex)

- Education details (School, grade, grades failed if any)
- Section 1(discussed below)
- Section 2 (discussed below)

3.10.2 Section 1

This section assessed the basic mathematical skills such as addition, subtraction, division, multiplication, estimation, fractions and rounding off. The questions are arranged according to grade appropriate tasks. The participants only completed their grade appropriate sections.

Table 1(Appendix C) outlines how Moosa and Segal (2011) divided the questions up according to the grade levels and how each section was scored. Table 2 (Appendix C) outlines the further subdivisions of what skill was assessed in each section according to the grade appropriate mathematical skill assessed.

In Section 1 (Basic mathematical skills), a score of 50 % was set as the minimum competency level of each grade. Section 1 had a total score of 70.

3.10.3 Section 2

According to Moosa and Segal (2011) Section 2 of the questionnaire assessed applied mathematical skills, where the application of ‘basic’ mathematical skills had to be applied to diabetes management and diabetes scenarios that one would be faced with on a daily basis.

Table 3 (Appendix C) stratifies the section 2 questions.

Section two comprised of 20 questions, each with a value of 2. The total score for this section was 40, which was converted to a total score of 80 as done so according to Moosa and Segal (2011) scoring requirements.

3.10.4 How the questionnaire was completed

The pre-test which was completed by the experimental and control group consisted of both section 1 and section 2. The post-test completed by both the experimental and control group consisted of a slightly altered section 2 which assessed the application of mathematical skills in diabetes management as the effectiveness of the intervention which was based on diabetes management was tested.

3.10.5. Scoring of the questionnaire

Scoring was done according to Moosa and Segal(2011) scoring system. When looking at each question a maximum of 2 was given if no assistance was required in completing the question, and it was correct. A score of 1 was given if assistance was needed in achieving the correct answer. A score of 0 was given if the participant could not complete the task, even after receiving assistance.

After taking each section into account the entire questionnaire was scored out of 150. The scoring of the questionnaires is attached to the questionnaires themselves (Appendix B and Appendix D).

3.11 Procedure

3.11.1 Permission

1. Ethics clearance was obtained from the Human Research Ethics Committee (Medical) (Appendix A)
2. Permission was obtained from Dr. David Segal (Paediatric Endocrinologist) and Dr. Fatima Moosa (Department of Paediatrics, Chris Hani Baragwaneth Hospital) before the research was conducted for the utilisation of the questionnaire, and to allow the researcher to conduct the research at Camp Nelu.
3. Consent and assent from the children as well as their caregivers was obtained. The researcher approached the parents/caregivers of the child participants when they dropped off their children for the diabetic educational camp on the Friday afternoon. The researcher explained the proposed research in detail and provided each parent/caregiver with an individual information letter and consent form (Appendix E), which informed the caregiver about the study. Confidentiality of their child was guaranteed, no risks or benefits were given to their child if they chose to participate or not participate in the study, and that participation was completely voluntary so their child could have withdraw from the study at any time. A request to conduct the research was then made and informed consent which adheres to all ethical procedures was obtained.
4. Once permission was granted by the caregivers, the children were then approached at the camp. The aim of the research was explained in detail and each child was given an

individual information letter and assent form (Appendix F), which was also explained to each child. In the letter it was clearly made that anyone who did not wish to participate would not be penalised nor would they have been advantaged or disadvantaged in any way if they chose to participate or not to participate in the study, their confidentiality was guaranteed and that participation in the study was completely voluntary. A request to conduct the research was then made and assent was obtained.

5. Issues with regards to confidentiality was addressed, and the participants were made aware that no-one else other than the researcher and their supervisors would have access to the data and responses to the questions. The questionnaires didn't require identifying information, thus confidentiality was guaranteed.
6. Once the researcher ensured that both consent and assent had been obtained the research process began. On the Friday evening between 8.00 and 8.30 pm all the child participants were given the pre-test (DMQ) (Appendix B), which assessed their basic numeracy skills as well as numeracy skills that are based around diabetes management. The researcher as well as Dr. Segal administered the test and it took approximately 30 to 40 min to complete.

3.11.2 Intervention

Experimental Group

- a) All the children at camp Nelu partook in the applied numeracy intervention (see Appendix G). The teaching activities took place on the Saturday, and were revised throughout the weekend. The following numeracy areas were covered in the applied numeracy intervention: time, fractions, averages, rounding, fractions, working with carbohydrates, measuring volumes, portion sizes, blood sugar formula and learning how to read tables and nutrition labels. All the educational sessions were done by the well trained facilitators and diabetic team (Dr. Segal (Paediatric Endocrinologist), Jinty Segal (Nurse), Beverly Balanco (Diabetes Educator).
- b) On Saturday morning from 9 am till 10.30 am the first numeracy educational lesson took place. Here the basics of diabetes were looked at and the children learnt how to work with carbohydrates. The following areas were covered:
 - Checking their blood sugar, and learning what a normal blood sugar level is. (20 min)

- What is a high blood sugar? What is a low blood sugar? And how one would put them in ascending and descending order. (20 min)
- They also learnt how to round off their blood sugar to the nearest whole number. (20 min)
- The children also learnt how to CARB count using items of food. Each item of food is equal to a certain amount of CARBS for example a slice of bread is equal to 1 CARB, half a roll is equal to 1 CARB and a small yogurt is equal to 1 CARB. The children learnt how to add the amount of CARBS up so that they could calculate how much they ate in a day. (30 min)
- c) To reinforce what they learnt each of these areas were revised throughout the course of the weekend. See Appendix G for camp outline.
- d) The next teaching session took place between 11.00 am and 13.00 pm on the Saturday. During this session the children were divided up into their grades (3-7). The participants were taught by 4 different tutors who all had tertiary qualifications. Each tutor was given a theme to teach in a specific amount of time. The children moved from one tutor to the next until the specified time at the station was up (times indicated below). The themes that were covered in this session were:
 - Time- This was taught using a readymade clock out of a paper plate- The tutors first taught the children the basics about the hands and then moved on to teaching am and pm and then to hourly times. The tutor then taught the children to count in five's around the clock; once this concept had been grasped they participated in a fun activity to guess the times given by the tutor. (20 min)
 - Fractions –The children were taught how to divide areas of a shape up, such as the plate they have been using for portions and then they were given a fun worksheet that requested them to colour in specific fractional areas of different shapes. They too were able to play with coloured water and beakers so that they could measure different amount of liquids and see the level of each colour liquid in the beakers (30 min)
 - Rounding off- This was taught using an anthill as a teaching resource (See Appendix H). After using the anthill to practice this skill the children were given a rounding off worksheet to complete (30 min)

- Blood sugar formulae and averages with a calculator- The children were given the formula that is used to work out their insulin dose and the tutor showed them how to apply it with examples. (30 min)
- The remaining 10 minutes was given to the rotation between stations.
- e) To reinforce what they learnt each of these areas were revised throughout the course of the weekend. See Appendix G for camp outline.
- f) The last educational teaching session took place between 17.00pm and 18.15pm on Saturday. In this session the children participants looked at nutrition and food labels. The following areas were covered:
 - What is seen as good foods for diabetic children, what is seen as bad foods for diabetic children? And if they are hungry what snacks could they eat that would be good for them? (15 min)
 - The children learnt how to read nutritional labels by looking at various food labels, this taught the children how to read off tables correctly and how to read for example the amount of grams of protein, carbohydrates or fat in a specific food item. The children also learnt to look at the weight of the food (in grams) for example a energy bar and compare it to the amount of grams each serving has, as a whole energy bar may have too many carbohydrates, therefore they may have to divide the bar into two. (30 min)
 - The participants learnt about portion sizes. The children were given a plate that was divided up into three areas: a half and two quarter areas. The children learnt to fill half the plate with Carbohydrates, one quarter was for vegetables and the last quarter was left for protein. During this session they also recapped CARB counting as they need to be able to count the amount of CARBS on their plate. (30 min)
- g) To reinforce what they learnt each of the educational areas were revised throughout the course of the weekend. The children checked their blood sugar levels 6 times in a full day with the doctors, nurses and team leaders. Each time they tested it they rounded off their blood sugar to the nearest whole number and they determined whether it's high or low. The children needed to give themselves insulin three times a day, each time they worked out their blood sugar levels they used the insulin formula to work out how much insulin they needed to give themselves. Each time the children got into their groups for sugar checks and

snacks they were asked what the time was. Diabetic children need to be aware of the time so that they know when they should be checking their insulin etc. At meal times the children got told how many CARBS were in each food item and they then calculated how many CARBS they were eating per meal. During these times they worked with the “fractional” portion plate to work out the different portion sizes that they were allowed to eat. They revised fractions every meal time as well as portion sizes. See Appendix G for camp outline.

- 1) On the Sunday afternoon at 12.00 all the children were asked to answer a slightly varied questionnaire which is based on the Diabetes Mathematical Questionnaire (Section 2) (Appendix D), to assess whether the intervention was successful. This questionnaire was administered by the researcher as well as Dr. Segal. The researcher ensured that she personally collected all the completed questionnaires.
- 2) Everyone who attended Camp Nelu formed the experimental group and took part in the intervention.

Control Group

- 1) A control group which was closely matched to the experimental group was selected from children who did not attend the camp. The data of the parents/caregivers and children who didn't attend the camp were found on a database at Dr. Segal's office, permission to access this data was obtained from Dr. Segal prior to the research. The parents were contacted telephonically. In the conversation with the parents/ caregivers the researcher explained the proposed research in detail and provided each caregiver with an individual information letter (Appendix E 2). A request to conduct the research was then made and informed consent which adheres to all ethical procedures was obtained.
- 2) Once permission had been granted by the caregivers, the children were then approached. The rationale of the research was explained in detail and each child was given an individual information letter (Appendix F 2), which was also explained to each child. A request to conduct the research was then made and assent was obtained.
- 3) Issues with regards to confidentiality was addressed by verbally making the participants aware that no- one else other than the researcher and their

supervisors have access to the data and responses to the questions. The questionnaires did not require identifying information, thus confidentiality was guaranteed.

- 4) Once the researcher had ensured that both consent and ascent had been obtained the research process for the control group began. The children were invited to Dr. Segal's offices where the research took place.
- 5) All the child participants were given the pre-test (DMQ) (Appendix B), which assessed their basic numeracy skills as well as numeracy skills that are based around diabetes management on a Friday afternoon.
- 6) The control group re-met at Dr. Segal's offices two days later to complete the altered Diabetes Mathematical Questionnaire (Section 2) (Appendix D) which was the post-test on the Sunday morning.

3.12 Data Analysis

Data was captured and analysed by Professor L. Paul Fatti (School of Statistics & Actuarial Science: University of the Witwatersrand) using Microsoft Excel 2007 spreadsheets.

As the data of the experimental groups pre-test and the control groups pre-test had an underlying approximate normal distribution a paired sample T- Test was utilized.

A paired sample T-Test was used to compare the means of the percentage scores between basic mathematical skills (section 1) and applied mathematical skills (section 2), and actual versus functional grades.

The data of the experimental groups post-test and the control groups post-test also had an underlying approximate normal distribution and therefore a paired sample T-test to indicate how separate the two measures were, and whether there was a significant difference between the post-test results of the experimental and control group

A Pre-test- Post-test within group paired sample T-test was used to compare the different scores between the Pre-test and the post-test of both the experimental and the control group to see whether or not their post test scores was significantly different from their pre-test scores.

CHAPTER 4: RESULTS

4.1 Demographics

The study group comprised of 58 children with type 1 diabetes (females =27 and males = 31). The experimental group consisted of 29 (females = 14 males= 15) and the remaining 29 formed part of the control group (females= 13 and males=16). Participants in the experimental group were closely matched according to their level of formal education, grade, age and sex to a research participant in the control group (See Table 4.1).

The Participants ages varied from 8 years old to 13 years of age (the mean of the experimental group=10.68y; mean of control group=11.24y) as illustrated in Table 4.1

All participants were in formal education between Grades 3 and Grade 8 (mean grade for control and experimental groups = 4.7). 20.68 % of the participants in both the experimental and control group in the study were educated in a private school, 48.27% attended fee paying schools, and 31.03% attended non-fee paying schools (See Table 4.1).

Table 4.1 Demographics

	Experimental Group	Control Group
Total Participants (n)	29	29
Female- n (%)	14 (48)	13 (44.8)
Male- n (%)	15 (51.7)	16 (55)
Mean Age (range 8-13 years)	10.68	11.24
Mean Grades (Range 3-8)	4.7	4.7
Type of School (n) (%)		
Private	6 (20.68)	6 (20.68)
Fee-paying	14(48.27)	14 (48.27)
No fee paying	9 (31.03)	9 (31.03)

4.2 Comparison between the control group and the experimental group (Pre-Test)

As can be seen from Table 4.2 Analyses revealed no significant difference in the scores of Section 1 (basic mathematical skills) of the experimental and the control group ($p=0.616$). Furthermore there was no significant difference for Section 2 (applied mathematical skills) in both groups ($p = 0.945$), indicating that they were closely matched.

Table 4.2 Comparison between the two groups

	Mean Difference	Standard Deviation	T- Score	p-value
Section 1	2.507	18.950	0.504	0.616
Section 2	-0.438	24.109	-0.069	0.945

4.3 Comparison Between Actual Grade and Functional Grade noted in the Pre-Test

As can be seen from Table 4.3 and Figure 4.1, as far as the *experimental group* is concerned, analyses revealed highly significant differences between the actual grade (mean average = 4.77) and their “functional” grades (mean average = 3.68) of individuals from Grade 3 to Grade 6 ($n=22$). Their actual grades were significantly higher than their “functional” grades in the first section of the paper ($p < 0.001$). 13 out of the 22 were functionally below their actual grade level according to the Tirisano Revised National Curriculum Statement (See Table 4.5). 9 of the individuals were attending a no-fee paying school, of which all failed the basic mathematical section, 1 individual of the 9 individuals who attended a fee-paying school failed and 3 of the 4 of the experimental group who were currently attending a private (independent) school failed the basic mathematical skills.

Table 4.3: Difference between Actual Grade and Functional Grade in the Experimental Group

Group	Sample	Mean Difference	Standard Deviation	T- Score	p-value
Experimental	22	1.091	1.192	4.294	<0.001

As can be seen from Table 4.4 and Figure 4.1, as far as the *control group* is concerned analyses revealed highly significant differences between the actual grade (mean average =

4.70) and the “functional” grades (mean average = 3.68) of individuals from Grade 3 to Grade 6 (n=22). Their actual grades were significantly higher than their “functional” grades in the first section of the paper ($p = 0.02$). 9 out of the 22 were functionally below their actual grade level according to the Tirisano Revised National Curriculum Statement (See Table 4.5). 9 of the individuals were attending a no-fee paying school, of which 7 failed the basic mathematical section, 2 of the 9 individuals who attend fee-paying schools failed the basic mathematical section and none of the 4 of the control group who were currently attending a private (independent) school failed the basic mathematical section.

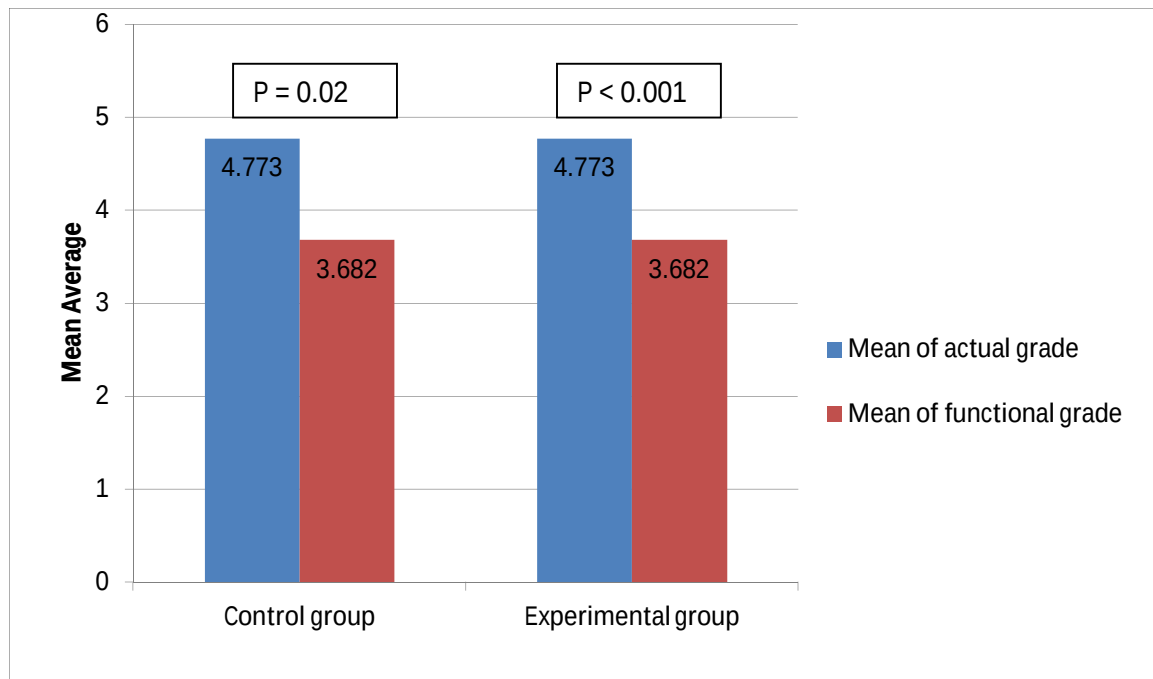
Table 4.4 Difference between Actual Grade and Functional Grade in the Control Group

Group	Sample	Mean Difference	Standard Deviation	T- Score	p-value
Control	22	1.091	1.477	3.464	0.002

Table 4.5 Percentage of the control group that performed below their actual grade level (n=22)

Group	Actual Grade	n (%)	Functional Grade	n (%)
Control	3	5 (22.73)	3	4 (18.18)
	4	6 (27.27)	4	5 (22.73)
	5	3 (13.64)	5	2 (9.09)
	6	9 (40.91)	6	6 (27.27)
Experimental	3	5 (22.73)	3	2 (9.09)
	4	6 (27.27)	4	2 (9.09)
	5	3 (13.64)	5	2 (9.09)
	6	9 (40.91)	6	4 (18.18)

Figure 4.1: Comparison of actual grade vs. functional grade between groups



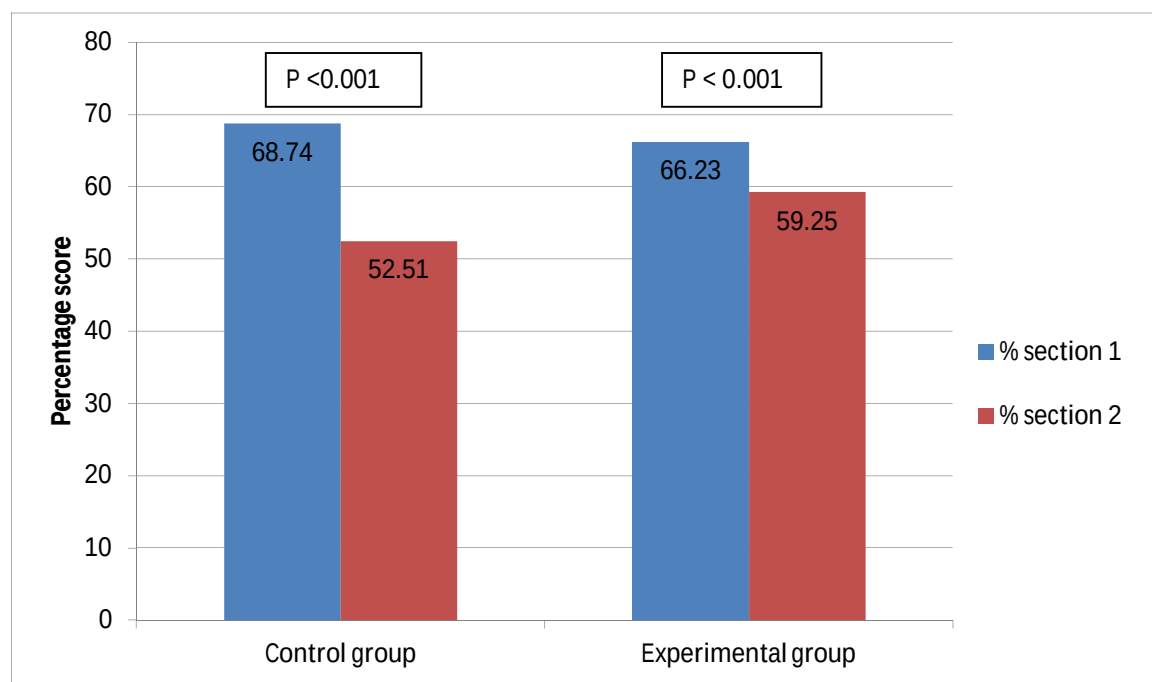
4.4 Comparison of the percentage scores for basic (Section 1) and applied mathematics (Section 2) (Pre-Test) in both the control and experimental group

As seen in Figure 4.2 analyses revealed that there was a significant difference between the *experimental groups* basic mathematical skills in section 1 (66.23 %; SD $\pm$ 20.49) and applied mathematical skills (Section 2) (52.95 %; SD $\pm$ 25.28).

As illustrated in Figure 4.2 analysis also revealed that there was a significant difference between the basic mathematical skills (section 1) (68.74 %; SD $\pm$ 17.28) and the applied mathematical skills (section 2) (52.51%; SD $\pm$ 22.88) achieved by the *control group* ($p < 0.001$).

This indicates that all the participants performed better in the basic mathematical skills (section 1) and struggled to apply these skills in section 2 (applied mathematical skills) ($p < 0.001$).

Figure 1.2: Comparison of % scores between the control and experimental group -Section 1 vs. Section 2(Pre-Test)



4.5 Comparison of scores In Pre and Post tests (applied mathematical section) for both the control and experimental groups after the intervention

As illustrated in Table 4.6 and Figure 4.3, the mean percentage scores of the *experimental group* for the applied mathematical skills (Section 2) pre-test were 52.95% ;SD± 25.28 and post-test were 60.86; SD±21.34 respectively. This indicates that the intervention was shown to be effective as analyses revealed that there is a highly significant difference between the Pre and Post Test (applied mathematical sections) of the experimental group which took part in the intervention ($p < 0.001$)(See Table 4.6).

As far as the *control group* is concerned as indicated in Table 4.6 and Figure 4.3, the mean percentage scores for the applied mathematical skills (Section 2) pre-test were 52.51 %; SD ±22.88 and post-test were 52.33%;SD± 22.15.The control group did not partake in any form of intervention, analyses supports this by revealing no significant difference between the Pre-Test (applied mathematical section) of the control group and or the Post Test (applied mathematical section) of the control group ($p= 0.87$) (See Table 4.6).

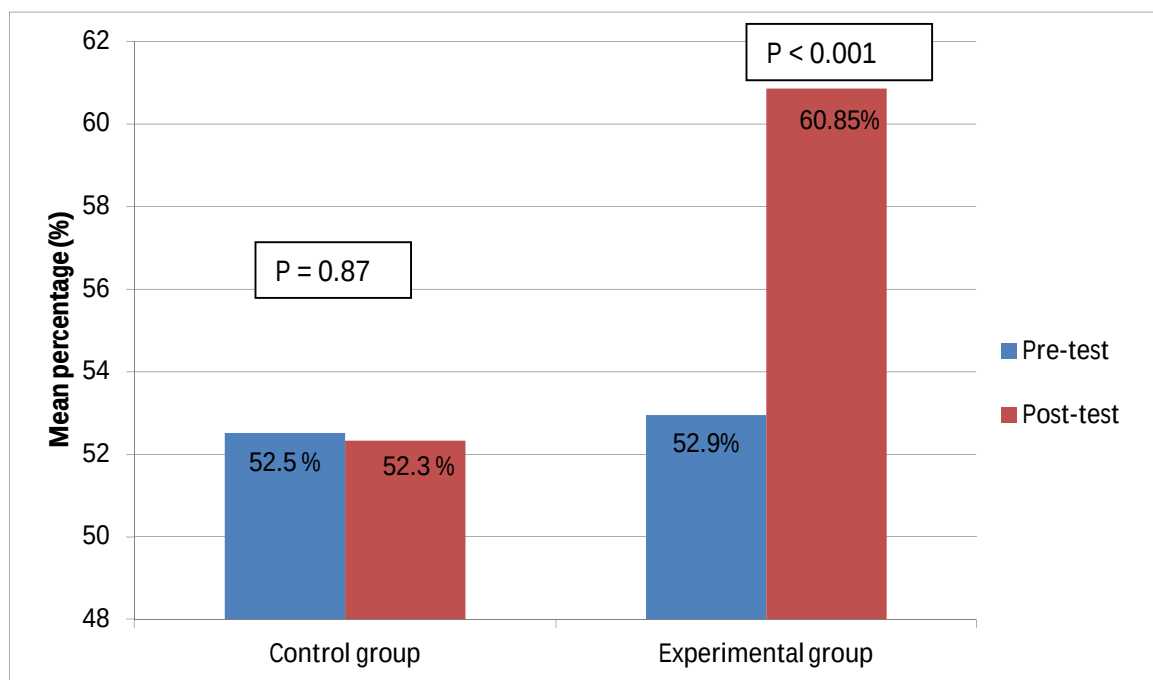
The effectiveness of the intervention was further supported by the significant total difference between the experimental and control groups ($p < 0.001$).

Table 4.6 The mean percentage scores of the pre and post intervention test in both the Experimental and Control groups.

Group	Mean Scores (%)		p-value
	Pre-Test	Post-Test (after intervention)	
Control	52.514	* 52.331	0.87
Experimental	52.952	60.855	p <0.001

*Control group had no form of intervention

Figure 4.3: Difference between the pre and post intervention, Experimental vs. Control group



4.6 Analysis of the individual questions

After the experimental group participated in the intervention global improvements were found. There were questions as can be seen from Table 4.7, which showed an overall improvement of more than 10 %. These questions covered areas such as division and multiplication related to CARB's, the rounding off of numbers, time relating to diabetes management, and interpreting information from a table.

There were also improvements in the areas of using the blood sugar formulae and rounding off the final answer as well as the utilisation of a calculator and being able to work out

averages. However these areas still need to be addressed as more than 50% of the research participants still failed in these areas after the intervention took place (See Table 4.7).

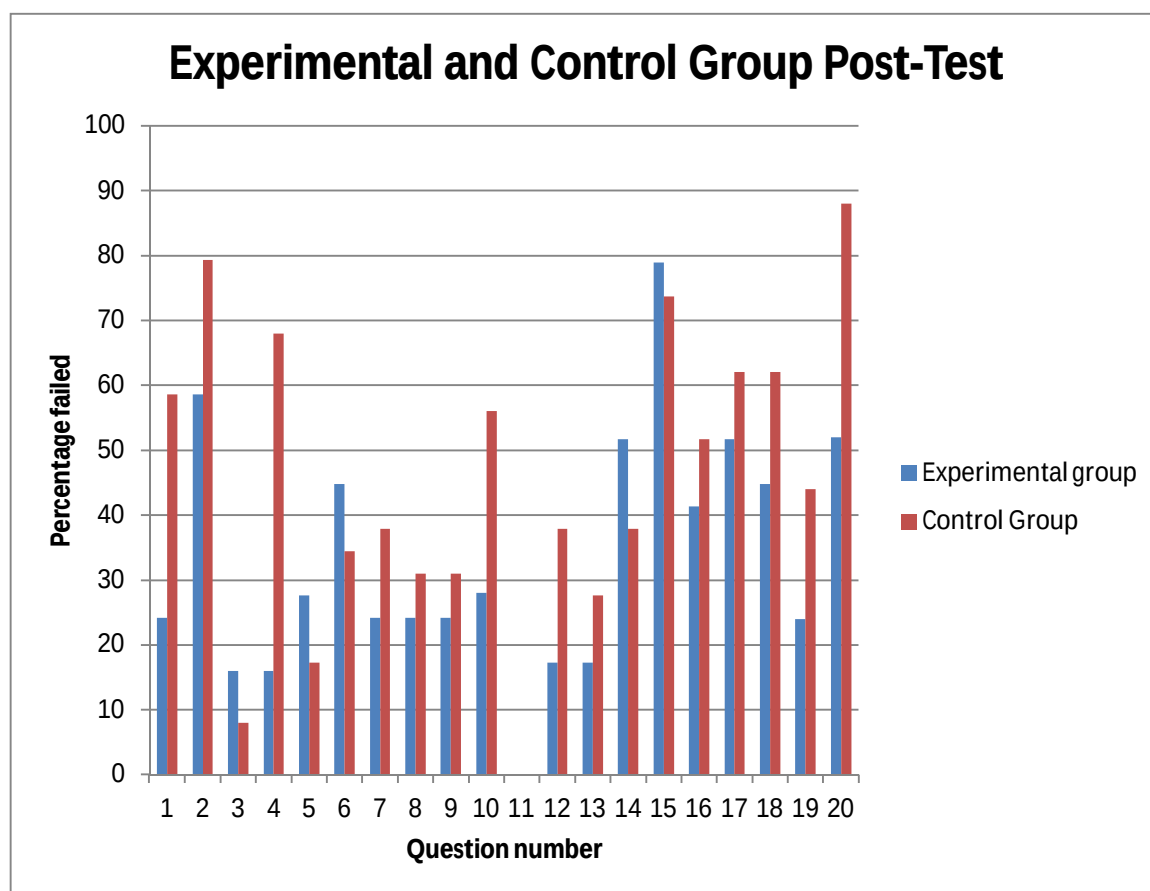
Analysis revealed post the intervention that there were still definite areas of deficits with regards to the participant's mathematical skills. The areas which still need to be addressed are as follows: basic addition skills, interpreting graphical 3D fractions, grouping data together, and solving basic word problems related to diabetes management of time and weight.

With regards to the control group as can be seen in Table 4.7 and Figure 4.4, they struggled with the questions in both the pre and post test as they did not take part in any form of intervention.

Table 4.7 Comparison in scores between the Experimental and Control group pre-post test after the intervention

Questions	Experimental group		Control Group	
	Pre-Test (% failed)	Post-Test (% failed)	Pre-Test (% failed)	Post-Test (% failed)
No. 1	44.82	24.14	55.17	58.62
No. 2	41.38	58.62	24.14	79.31
No. 3	20	16	16	8
No.4	56	16	44	68
No. 5	20.69	27.59	13.79	17.24
No. 6	48.28	44.83	37.93	34.48
No. 7	34.48	24.14	37.93	37.93
No. 8	44.83	24.14	48.28	31.03
No. 9	31.03	24.14	51.72	31.03
No. 10	40	28	56	56
No. 11	0	0	0	0
No. 12	20.69	17.24	31.03	37.93
No. 13	20.69	17.24	48.28	27.59
No. 14	41.38	51.72	37.93	37.93
No. 15	89.47	78.95	63.16	73.68
No. 16	37.93	41.38	41.38	51.72
No. 17	44.83	51.72	55.17	62.07
No. 18	62.07	44.83	68.97	62.07
No. 19	40	24	52	44
No 20	72	52	88	88

Figure 4.4: Comparison in scores between the Experimental and Control group pre-post after the intervention



CHAPTER 5: DISCUSSION

5.1 Introduction

As discussed above, according to Diabetes South Africa (2010) there are approximately 4-6 million people in South Africa with diabetes of which, 5 – 10% of this population have Type 1 diabetes today. This number is increasing on a daily basis (World Health Organisation, 2011). Diabetes type 1 is prevalent amongst children and adolescents, and in order for a child to be able to manage their diabetes effectively, numeracy skills are vital (Semiz et al., 2001).

It is evident through research that children with diabetes worldwide have poor numeracy skills, however, there is also a lack of research on the effectiveness of a numeracy intervention specifically related to diabetes, especially in the South African context. This study served as a starting point for the assessment of the effectiveness of diabetes numeracy interventions in a South African child population. A discussion of the results follows.

5.2 Demographics

The participant population was comprised of 58 children (27 females and 31 males) between the ages of 8 and 13 who had been previously diagnosed with type 1 diabetes. However, South Africa is a nation of diversity, therefore many of these children came from different cultural and religious backgrounds (SouthAfrica.info, 2011).

The experimental group consisted of 29 children who had selected to participate in the weekend intervention at camp Nelu. They came from different cultural backgrounds, but were all in formal education between Grades 3 and Grade 8. Their educational settings differed in that 6 of the participants were educated in a private school, 14 attended fee paying schools, and 9 attended no-fee paying schools.

Participants in the experimental group were closely matched according to their level of formal education, grade, age, and sex to a research participant in the control group. Therefore 29 children formed part of the control group, of which 6 of them attended private schools, 14 of them attended fee paying schools, and nine attended no-fee paying schools.

When considering whether the two groups were matched appropriately, it was important to assess the scores of Section 1 (basic mathematical skills) that were achieved by both groups.

Analyses revealed no significant difference in the scores of the experimental and the control group ($p=0.616$), which indicates that they were closely matched. This was further supported by the fact that there was no significant difference for Section 2 (applied mathematical skills) in both groups ($p = 0.945$).

5.3 ‘Actual Grade’ vs. ‘Functional Grade’

Results in the present study revealed highly significant differences between the ‘actual’ grade and the ‘functional’ grades of individuals from Grade 3 to Grade 6, in both the control ($p = 0.02$) and the experimental group ($p < 0.001$). This suggests that many of the participants are lacking the basic mathematical skills needed to function in their actual grade level, according to the Tirisano Revised National Curriculum Statement.

By comparing the results in this present study to the different schools that were attended by the participants and their basic mathematical (Pre-Test: Section 1) results, it was found that 88.8% of the individuals that failed were attending no-fee paying schools, 16.6 % attended fee-paying schools, and 37.5% attended private (independent) schools. Even though this is a small sample to work from, it is nonetheless a concern. A similar concern is shared by the Department of Education, who released a report on the Annual National Assessments in July 2011, in which data was collected from about 1800 schools in South Africa. In this assessment individuals from grade 3 to grade 6 were tested in both languages and mathematics (Department of Education, 2011). One hundred schools per province, per grade, were selected for the annual national assessment. Data that was analyzed covered 19,470 Grade 3 learners in 827 schools and 19,397 Grade 6 learners in 840 schools. The tests were based on the National Curriculum Statement and the achievement milestones which had been formed as part of the Foundations for Learning Campaign. Overall the findings revealed that the percentage of learners that are reaching what they call an “achieved” level of performance varied from 12 to 31% (Department of Education, 2011). Results indicated that in the Gauteng province, the average percentage scores for the grade 3 literacy and numeracy were 35% and 30%, respectively. The percentage scores for languages and mathematics of the grade 6 learners were 35% and 37%(Department of Education, 2011). The percentage of performers that were performing at adequate levels, according to the Department of Education (2011) was “unacceptably low” (p. 34).

There are many different factors that could affect the low numerical skills in patients and school performance. According to the Education Labour Relations Council (2005), external factors such as a low income, and schools with a high rate of HIV/AIDS, are seen as serious challenges in the learning environment. The amount of learners that one has in a classroom can also affect the learning that takes place in that classroom, supporting this notion research has indicated that larger classes in impoverished areas have contributed to low matric pass rates (Education Labour Relations Council, 2005). Research conducted by Hill, Rowan, and Ball (2005), which explored how a teacher's knowledge in mathematical skills influenced a student's achievement, found that teachers mathematical knowledge was significantly related to the performance of a student.

Through the present study and recent research there are still many challenges in the South African schooling systems, but due to the annual national assessment that was conducted, enhanced focus on what must be improved in the future is expected. An application of workbooks in the classroom will be provided to move classroom practices in a more positive direction, and in 2012, another annual national assessment will be conducted to assess the effectiveness of the workbooks and the implementation of the national curriculum, so the quality of education in South African can only improve (Department of Education, 2011).

5.4 Basic Numerical skills versus Diabetes Numerical Skills (Pre-Test)

As mentioned earlier, Rothman et al. (2006) found that many patients with diabetes lack the basic numerical skills that would assist one in managing diabetes effectively, and many of those with poor numeracy skills are more likely to experience hypoglycaemic episodes (Rothman et al., 2009). Having numeracy skills does not only mean having the ability to do algebra, fractions, calculations, measurement, time, and graphs (Huizinga et al., 2008), but it is also the ability to apply these skills to everyday life (Rothman et al., 2006). The lack of basic numerical skills in children will affect their diabetes management at a later stage. (Cavanaugh et al, 2008; Osborne et al., 2009; Rothman et al., 2006; Rothman et al., 2009; Moosa & Segal, 2011).

The participant's diabetes numeracy skills prior to the intervention were assessed to see whether they were able to apply their basic numerical skills to diabetes related questions.

Analysis revealed that there was a significant difference in the scores of the basic mathematical skills (section 1) and the applied mathematical skills (section 2) that was achieved by the experimental group ($p < 0.001$).

Analysis further revealed that there was a significant difference between the scores of the basic mathematical skills (section 1) and the applied mathematical skills (section 2) achieved by the control group ($p < 0.001$).

These results indicated that both the experimental and control group performed better in section 1 (basic mathematical skills) and struggled to apply these skills in section 2 (applied mathematical skills), to more diabetes-appropriate questions.

This is unfortunate, as the application of basic mathematical skills is vital for the management of diabetes. Individuals need to be able to apply basic numerical skills such as addition and subtraction to CARB count, count their calories, and interpret blood sugar levels (Huizinga et al., 2008; Cavanaugh et al., 2008; Moosa & Segal, 2011). Individuals with diabetes also need to know how to tell time so that they can monitor when they must test their blood glucose, when to administer insulin, and when they should eat their next meal (Moosa & Segal, 2011). The ability to interpret data from nutritional labels and graphs is essential in understanding what they are eating, and in being able to plan for their next meal. The ability to sequence numbers correctly allows diabetic patients to understand patterns in their blood glucose levels (Moosa & Segal, 2011). They also need to be able to apply the diabetes formulae to determine the correct insulin doses, understand the relevance of HbA1c levels and glycemic control and have an understanding of averages (Cavanaugh et al., 2008). Therefore it is important to have the basic mathematic skills as a foundation, but it is just as important to be able to apply these skills.

The importance of numeracy is further echoed by White, Wolff, Cavanaugh, and Rothman (2010), who posit that numeracy is essential in diabetes care. Adequate numeracy skills are needed to follow dietary plans, count carbohydrates, interpret blood glucose, and administer medication (Huizinga et al., 2008; Cavanaugh et al., 2008; White et al., 2010).

The outcomes of the current study were further supported by the results from a study done by Cavanaugh et al. (2008), who found that individuals who had low numerical skills struggled in the areas of applied numerical skills. Furthermore Moosa and Segal (2011), assessed the basic numerical skills of diabetes children and their caregivers, compared to their applied

numerical skills, and found that the mean percentage score of the children participants for the applied section was 56.63 %, which was lower than the percentage scored in the basic mathematical section, which was 69.3%. This further supports to notion that individuals with diabetes struggle to apply the basic mathematical skills.

5.5 Intervention effectiveness

The main objective of the current study was to determine if there was a difference in the participant's diabetes numeracy skills after the intervention took place, and to assess whether the intervention was effective, by comparing the scores of the pre and post tests of the experimental group, and comparing it to the results of the control group.

The effectiveness of the intervention was supported by a highly significant difference between the Pre and Post Test (applied mathematical sections) of the experimental group ($p < 0.001$). Analysis of scores for the applied mathematical skills (Section 2) pre-test (52.95%) and post-test (60.86%) for the experimental group indicated that an improvement was made.

Furthermore there was no significant difference between the Pre-Test (applied mathematical section) and the Post-Test (applied mathematical section) of the control group ($p=0.87$) and the control groups scores for the applied mathematical skills (Section 2) pre-test (52.51 %) and post-test (52.33%), further indicating that no improvements had taken place.

The intervention was shown to be effective for those who attended the camp, as there was a highly significant difference between the Pre and Post Test (applied mathematical sections) of the experimental group ($p<0.001$). This was not found in the control group ($p= 0.87$). Thus, overall there was a vast improvement in the experimental group's diabetes numerical skills.

A study was conducted by Baker et al. (1998), and as mentioned earlier, they found that even though 73% of the patients had participated in some form of diabetes education class, 50% of them still did not know the symptoms of hypoglycaemia, and 42% did not know what a normal blood glucose range was. Therefore it was questioned whether a diabetes numerical intervention would assist individuals in managing their diabetes. The diabetes camps that have taken place have been based on symptom control and self-management (Semiz et al., 2001). According to Plante et al. (2001) Pre and Post test evaluations have indicated that individuals have gained knowledge on previous camps, yet there have been no controlled

studies of camps for children with diabetes. This idea has been supported by Hampson et al., 2001, who analysed the effectiveness of 21 pre-post studies. Yet none of these studies had any form of a control group. This could be understood in that, ethically, individuals don't want to limit participation in the camp intervention (Hampson et al., 2001). In the present study a control group was formed and closely matched to the experimental group. Both groups completed the pre-post test within the same time frame but the control group was not present at the camp, instead completing the questionnaire at a different time after the diabetes camp had taken place. They were also invited to attend the next camp on diabetes education.

Furthermore, as posited by Walker and Pearman (2009), there has not been much research with regards to the efficacy of camp programmes with individuals who have a chronic disease such as diabetes. All the individuals who attended Camp Nelu have diabetes, therefore they are all able to help, understand, and provide each other with peer support (Sawyer & Aroni, 2005). This alone may play a large role in why the children were able to do so well in the post-test. The facilitators, or group team leaders, are also adolescents with diabetes, and they have been trained to help look after the younger children throughout the weekend. They are with them all the time, and even stay with them in their bungalows to ensure that their sugar levels are maintained throughout the weekend. They can be seen as role models to the younger children with diabetes, and this form of peer education, according to the GOLD Peer Education Development Agency South Africa (2010), is considered a very effective way to educate young individuals in any area.

After exploring the effectiveness of summer camps for diabetic children, Semiz et al., (2001) also found that there was a significant improvement in self-management after the camps had taken place. The present study also indicated a significant improvement due to the basic and applied numerical diabetes education. However, Semiz et al., (2001) was not able to find any significant improvement in the long-term effects of the educational camps, and as no follow-up was conducted in this present study, the long-term effects of the diabetes camp could not be determined. However, as in the mind of Semiz et al., (2001), the researcher believes that any form of diabetes educational camp is invaluable.

5.6 Areas of non-improvement

In the present research it was not only important to determine if there had been any improvement in the participants numeracy skills overall, but it was also important to assess in

what areas the research participants improved, and what areas still need to be addressed in the future.

This present study found a 10% improvement in the areas of division and multiplication related to CARBS's, the rounding off of numbers, time relating to diabetes management, and interpreting information from a table.

There were also improvements in the areas of using the blood sugar formulae and rounding off the final answer, the utilisation of a calculator, and being able to work out averages. However, these areas still need to be addressed as, even though there were improvements, more than 50% of the participants still failed in these areas after the intervention took place.

All the above sections were individually covered in the intervention, and although there is no specific research indicating why individuals would improve in these specific areas, one can understand that improvements were made as, according to the National Research and Development Centre for adult literacy and numeracy (2004), receiving any form of numeracy tuition would produce more progress than not receiving it at all. The groups of children that took part in the intervention consisted of approximately 8 members and, as discussed earlier, the Education Labour Relations Council (2005) stated that the amount of learners that one teaches in a classroom can affect the learning that takes place (Education Labour Relations Council, 2005). This too may have had an influence on the results.

Post intervention analysis revealed that there were still definite areas of deficits with regards to the participant's mathematical skills. The areas which still need to be addressed are as follows: basic addition skills, interpreting graphical 3D fractions, grouping data together, and solving basic word problems related to diabetes management of time and weight.

The participants may have still struggled in the areas mentioned above due to their lack of basic mathematical understanding, and this may be a result of an ineffective schooling background, a bad learning environment, as well as other factors discussed earlier that relate to low basic mathematical skills such as socio-economic status (Education Labour Relations Council, 2005) and family dynamics. Many of the participants struggled to answer the word problems correctly. To understand what these questions entail, one must have basic literacy skills, and as discussed earlier, low literacy skills are common amongst diabetic patients (Rothman et al., 2006). The area of literacy was not addressed in this research project. The

fact that the intervention was short in nature and that there was a lot of information to take in, in a short period of time, may have also affected how they did in the final post-test.

It was found in the study conducted by Moosa (2011) that there were certain areas which the research participants really struggled with. The main areas in which they struggled covered the fields which measured rounding off formulae, as well as data interpretation. Therefore one can conclude that there were definite improvements in some of the areas in which the participants struggled in the earlier study done by Dr. Fatima Moosa (Moosa & Segal, 2011).

5.7 Conclusion

The research aimed to explore the efficacy of an applied diabetes numeracy intervention in a South African Type 1 Diabetic Child Population. Overall, the results indicated that the diabetes numerical intervention was highly successful in improving the participant's diabetes numerical skills.

Analysis of the results from the study revealed that there was a significant improvement in the diabetes numerical skills of the experimental group, yet, as expected, there was no improvement in the control group's numerical skills who did not participate in the intervention. These results highlight the effectiveness of the applied diabetes numeracy intervention .

In this present study it was found that the numeracy skills of both the experimental and control group were below their "actual grade" level. On average, the research participants were functioning a grade below their "actual grade" level, which indicates that numerically they are not performing at a grade-appropriate level, according to the Tirisano Curriculum Statement. These results were not only supported by the study performed by Moosa and Segal (2011), but also by the South Africa's Department of Education (2011).

It was evident through the results that the participants performed better in the basic mathematical skills section than the diabetes numeracy skills section. Although they did not perform particularly well in either, they were still able to perform better in the areas that measure basic mathematical skills than the areas which measured their diabetes numeracy skills. This indicates that they really struggled to apply their basic numerical skills to diabetes related tasks, which is a concern, as the application of basic mathematical skills is imperative for the effective management of diabetes .

After the intervention took place there were definite areas of improvement, however there were also areas which did not improve. These included basic addition skills, interpreting graphical 3D fractions, grouping data together, and solving basic word problems related to diabetes management of time and weight. The participants may have found these areas difficult due to a lack of basic mathematical understanding, which can be linked to many factors discussed earlier, or they may have found it difficult to take in so much information in such a short space of time.

To conclude, the present research study highlights the importance of basic numerical skills in the understanding of diabetes numeracy, and how to manage it effectively. After looking at all the different aspects of this study it is evident that the main objective of this research project, which was to explore the efficacy of an applied diabetes numeracy intervention in a South African diabetic Type 1 child population, was achieved. Furthermore, this research study provides information on the difficulties that South African education faces. It also highlights which areas of diabetes numeracy still need to be addressed. The current study is a step closer in addressing the numeracy difficulties that are experienced by the South African diabetic Type 1 child population.

5.8 Limitations of the study

- 1) The questionnaire that was utilised was never tested on children that did not have diabetes.
- 2) The Tirisano Revised South African National Curriculum Statement (RNCS) for mathematics was used as a basis for the development of the questionnaire.
- 3) As the children participants themselves filled in the questionnaire very limited information about the duration of their diabetes and the age of onset was obtained.
- 4) The questionnaire was designed to measure the participant's numerical diabetes skills, yet differences in diabetes education and differences in management of diabetes could affect the results.
- 5) The intervention, although effective was very brief, therefore it would be beneficial to make this intervention longer, or do repeated interventions to ensure sustainability.
- 6) It is unknown whether there were any long-term benefits of the intervention, and whether it affected the participant's long-term diabetes management.

- 7) English was not always the research participants first language, even though there was assistance available to them, with regards to their home language, this could have affected the way in which they answered a question.
- 8) The study would have been more focused if fewer grades were involved in the intervention. For example if there were 29 Grade 4's.

5.9 Strengths of the study

- 1) This is only the second study in South Africa which has highlighted the lack of basic numerical skills in the diabetes population and therefore it has addressed an area with little research yet of great importance.
- 2) Internationally there have been very limited studies on the effectiveness of diabetes numeracy intervention programs. No research on the effectiveness of a diabetes numeracy intervention has taken place in the South African context until this research project.
- 3) Most of the research on the effectiveness of numeracy interventions specifically related to diabetes have only utilised an experimental group. Therefore, by using a control group in this study it only makes the results stronger.
- 4) Although mentioned in the limitations that the study would have been more focused if fewer grades were involved in the intervention, the fact that all the different grades struggled in the basic mathematical sections indicated that numeracy is a national problem.

5.10 Suggestions for future research

Through all the research done in the past and including this study it is evident that numeracy skills are low in diabetes Type 1 patients in South Africa.

- 1) The present study has proven that a short diabetes numeracy intervention can be effective in addressing diabetes numerical skills. However, improvements on the participant's long-term diabetes management need to be studied and documented. More diabetic specific educational programs need to be developed, which include diabetes management, as well as basic numerical skills and the long-term effectiveness of these programs needs to be assessed. It would also be beneficial to form educational programs that deal specifically with the areas in which the

participants still struggled to successfully complete after the intervention had taken place.

- 2) Numerical skills are vital for effective diabetes management, and through this study it is evident that patients with diabetes not only struggle to perform at a grade appropriate mathematical level but struggle even more to apply the basic numerical skills to diabetes related tasks. Therefore research into how one could improve the numerical skills of diabetes patients and how one could implement specific programs would also help in addressing the management of diabetes in a type 1 child population in South Africa.

5.11 Personal Reflection

I found it very difficult to determine how I experienced the process of conducting this research project, as my journey has been both exciting and memorable but at times overwhelming. I knew that by selecting this research topic I was throwing myself into unfamiliar waters, yet this alone excited me. I was faced with the most challenging aspects of my research project early on in the year. Due to time constraints, I had the task of organising my proposal and medical ethics before the middle of February, during this time I truly believed that I was trying to achieve an unattainable task. By accomplishing this goal I got to experience the most memorable part of my journey, which was attending the camp with the children with diabetes. I was humbled by the way in which they dealt with their disorder, and was astounded by how one could teach such a young child to take control of their diabetes and manage it effectively. I thoroughly enjoyed working with the families of the children with diabetes, and for the most part enjoyed putting it all together. After completing all the practicalities of the research I felt rather fatigued, but was again motivated by the results that I received. Putting the research project together at the end of the process was exhausting, frustrating, and, although I was aware that the end was near, at times I felt completely defeated by the work load, and doubted my abilities to complete it to the high standards I had originally set myself.

There have been both high and low moments in this research process, and although I had to be encouraged at times, I took every moment, be it good or bad, as a learning one. I have been privileged to work alongside such profound individuals, and the knowledge and insight that I have gained from both them and the process have been invaluable.

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Appendix A: Ethics clearance

Appendix B: PRE-TEST:

Study: Exploring the Efficacy of an Applied Diabetes Numeracy Intervention in a South African Type 1 Diabetic Child Population.

Questionnaire- Demographics

Study Number	
Date of Birth	
Age	
Address	
School	
Current Grade/ Grade attained	
Have you had to repeat a grade? If yes, which grade?	
Duration of diabetes	

Basic Mathematical Skills (sections arranged according to equivalent grades)

SECTION 1

Question 1

Complete the following sequence:

10, __ , __ , 40, 50, __ , __ , __ , 90, __

Question 2

Write the following numbers in words:

1 - _____

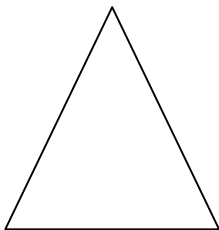
5 - _____

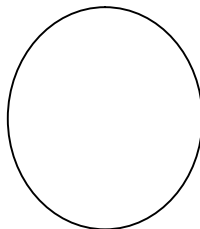
20 - _____

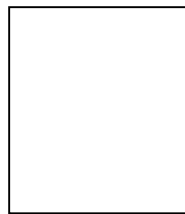
26 - _____

Question 3

What are the following shapes?







Question 4

Calculate the following:

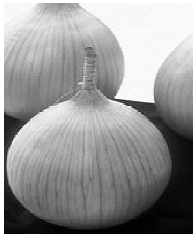
$1 + 2 =$ _____

$4 + 5 =$ _____

$10 + 8 =$ _____

Question 5

Circle the fruit objects:



SECTION 2

Question 1

Complete the following sequences:

1) 25, _____, _____, 40, 45, _____, _____, _____, 65

2) 180, 182, _____, _____, _____, 190, 192

Question 2

Circle the correct fraction:

One half $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$

One quarter $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$

One third $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{4}$

Question 3

Calculate the following:

1) $10 + 14 =$ _____

2) $5 + 4 =$ _____

3) $2 + 6 = \underline{\hspace{2cm}}$

Question 4

Arrange the following in correct order:

Monday _____

Friday _____

Thursday _____

Question 5

What time is shown on the following clocks?



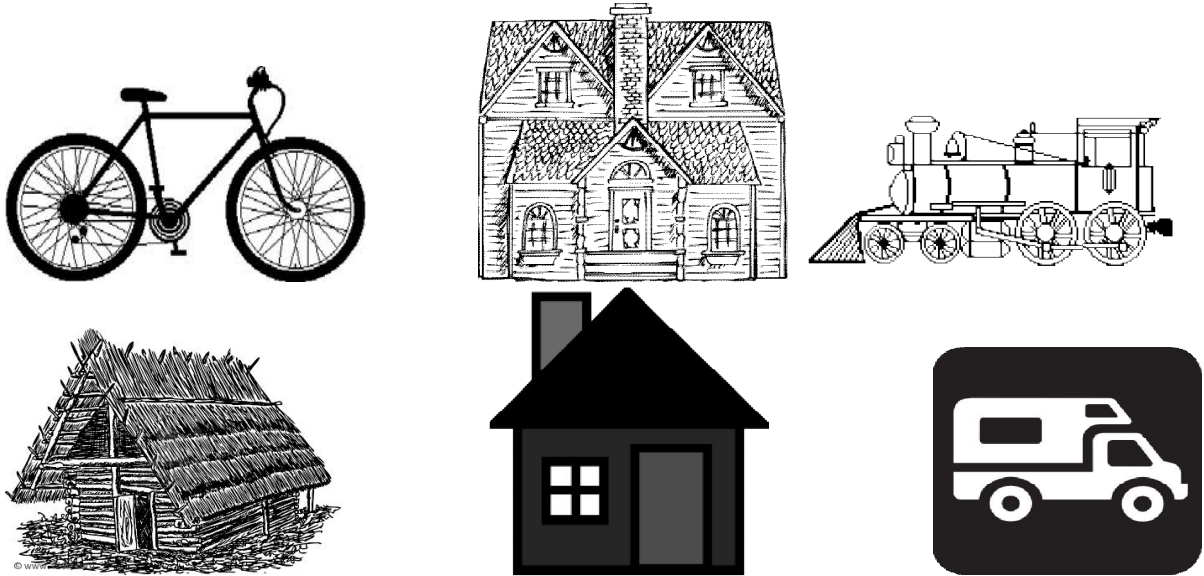




Question 6

Group the following:

- 1) Transport vehicles
- 2) Houses



SECTION 3

Question 1

Complete the following:

20, 40, _____, _____, 100

Question 2

If I give you R5 and you buy sweets for R2, how much money do you have left?

Question 3

Calculate the following:

- 1) $100 + 55 =$
- 2) $20 \times 10 =$
- 3) $50 \div 5 =$

Question 4

Complete the following:

- 1) 1 hour = _____ minutes
- 2) $\frac{1}{2}$ min = _____ seconds
- 3) 1 cm = _____ mm

Question 5

How many days are there in a week? _____

Now list them in the correct order starting at the first day of school:

Question 6

How many months are there in one year?

SECTION 4

Question 1

Round off the following to the nearest whole number:

- 1) $22.2 =$ _____
- 2) $16.7 =$ _____
- 3) $13.4 =$ _____

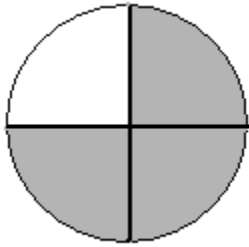
Question 2

Complete the following:

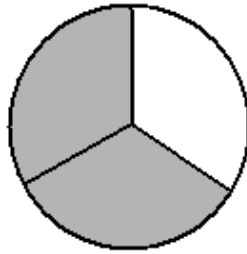
25, 20, _____, 10, _____

Question 3

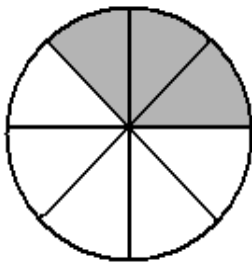
Complete the following fractions:



4



3



3

Question 4

Complete the following:

$$25 \times 20 =$$

$$202 \div 2 =$$

Question 5

$$\text{If } 5 \times 3 = 15$$

$$\text{Then } 15 \div \underline{\hspace{2cm}} = 5$$

Question 6

Write the following in fraction form:

$$1 \div 6 = \underline{\hspace{2cm}}$$

$$1 \div 8 = \underline{\hspace{2cm}}$$

Question 7

Draw a box (in three dimension)

SECTION 5

Question 1

Complete the following:

$$255 \times 50 = \underline{\hspace{2cm}}$$

$$500 \div 25 = \underline{\hspace{2cm}}$$

Question 2

Complete the following sequence:

$$\frac{1}{2}, 1, \underline{\hspace{1cm}}, \underline{\hspace{1cm}}, 2\frac{1}{2}$$

Question 3

Round off the following to the nearest hour:

$$22\text{h}07 = \underline{\hspace{2cm}}$$

$$10h57 = \underline{\hspace{2cm}}$$

Question 4

Write the following equivalent fractions:

3	=	
4		8

1	=	3
		27

Question 5

Complete the following:

$$\text{Double } 36 = \underline{\hspace{2cm}}$$

$$\text{Halve } 36 = \underline{\hspace{2cm}}$$

Question 6

Work out the following equation using a calculator:

$$\sqrt{25 \times 100} =$$

Question 7

Calculate the following:

$$2,5 + 4,5 + 3 = \underline{\hspace{2cm}}$$

SECTION 6

Question 1

Convert the following into percentages:

$$60/100 = \underline{\hspace{2cm}} \%$$

$$25/100 = \underline{\hspace{2cm}} \%$$

Question 2

R45,75 is equivalent to cents

Question 3

If I get paid R5 a day, and work Monday to Friday, how much do I earn in two weeks?

Question 4

Complete the following:

$$2 \times \underline{\hspace{2cm}} - 8 = 0$$

$$5 + 5 - \underline{\hspace{2cm}} = 8$$

Diabetes related questions

Question 1

If 1 CARB = 15g

Then how many CARBS in 60g?

45g?

75g?

Question 2

1 CARB = 1 slice of bread

= 1 fruit

= 1 biscuit

= $\frac{1}{2}$ roll

= $\frac{1}{3}$ cup rice

= 1 small yogurt

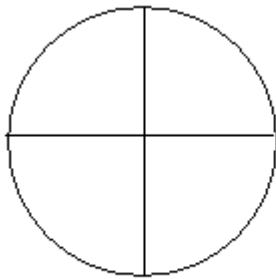
How many CARBS in:

2 slices of bread + 1 small yogurt + 1 fruit?

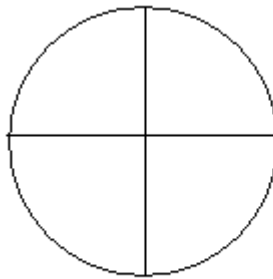
Question 3

Colour in the equivalent of the fraction on the picture graph:

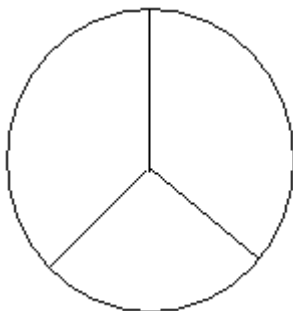
One half ($\frac{1}{2}$)



One quater ($\frac{1}{4}$)



One third ($\frac{1}{3}$)



Question 4

If $\frac{1}{2}$ cup cereal = 1 CARB

Then 1 $\frac{1}{2}$ cups of cereal equals to how many CARBS?

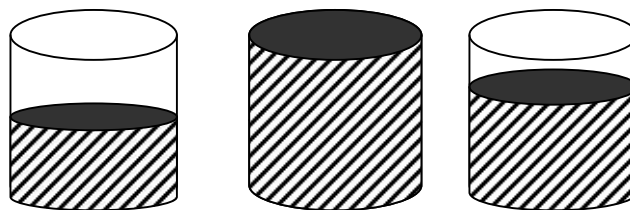
Question 5

Match the following equivalents:

$\frac{1}{2}$ can

$\frac{3}{4}$ can

1 full can



Question 6

Round the following numbers to the nearest 10:

2 = _____

5 = _____

8 = _____

12 = _____

16 = _____

19 = _____

Question 7

Round off the following answers to the nearest even number:

8 protophane + 3 actrapid = _____ total units of insulin

Round it down to the nearest even number = _____ units

8 protophane + 5 actrapid = _____ total units of insulin

Round it up to the nearest even number = _____ units

Question 8

If bedtime is at 10pm and supper at 6pm, how many hours after supper is bedtime?

Question 9

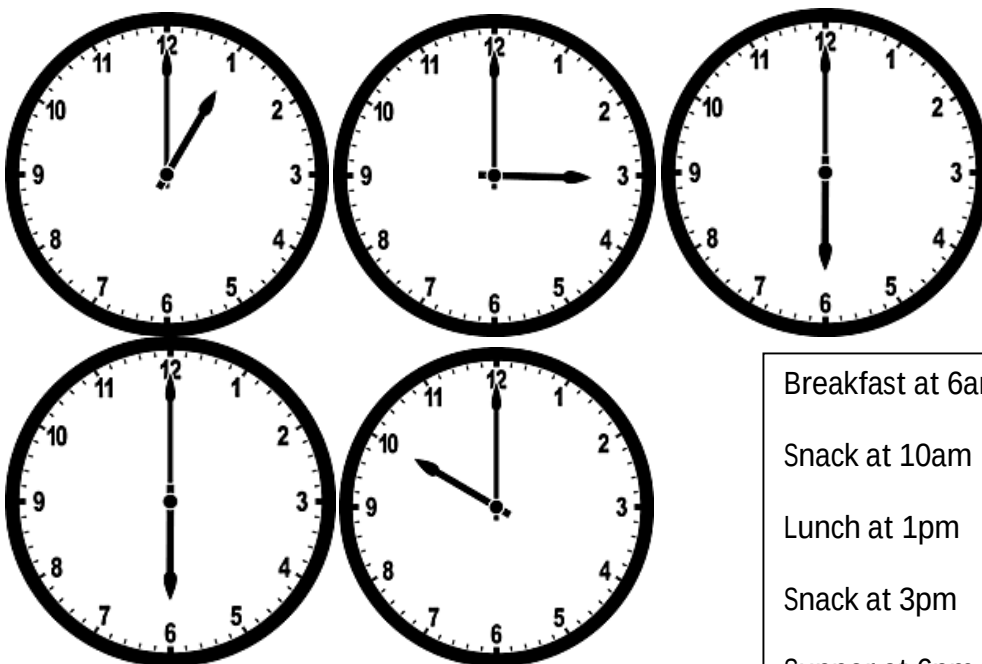
If a snack should be taken 2 hours after breakfast and if breakfast is at 7 am, then what time should the snack be taken?

Question 10

If your insulin needs to be taken 30 minutes (half an hour) before breakfast and if breakfast is at 7am, then at what time should your insulin be taken?

Question 11

Match the following:



Breakfast at 6am

Snack at 10am

Lunch at 1pm

Snack at 3pm

Supper at 6pm

Question 12

Arrange the blood sugar levels in ascending order (from lowest to highest):

23, 27, 18, 7, 14

Question 13

Arrange the blood sugar levels in descending order (from highest to lowest)

17, 22, 5, 31, 3

Question 14

Target blood sugar levels should be between 4 and 10. Circle the target values:

	breakfast	snack	lunch	snack	supper	Bedtime
Day 1	2	12	14	7	4	9
Day 2	22	4	5	16	18	20
Day 3	24	3	6	15	17	19
Day 4	21	26	28	8	30	10

Question 15

Work out your insulin dose using this formula:

$$\frac{\text{Formula: (Blood sugar - 6)}}{3}$$

Blood sugar = 18 then the answer is _____

Blood sugar = 12 then the answer is _____

If blood sugar = 11 then the answer is _____ round off the last dose to the nearest whole number = _____

If blood sugar = 9 then the answer is _____

Question 16

If you need to give 3 units of insulin every hour, after 3 hours how many units of insulin will be given?

Question 17

If you need to give 1 unit of insulin for every 10kg of body weight and if you weigh 50kg, then how many units of insulin needs to be given?

Question 18

If one fizzy drink has 12g of CARBS per 100ml. In a 500ml bottle, how many grams of CARBS are there?

Question 19

The following appeared on an energy bar label:

	Per 100g	Per 50g serving
Protein	9g	4.5g
CHO	60g	30g
Fat	3g	1.5g

How many grams of CHO are there in one serving?

Question 20

The following were blood glucose readings in a diary. Calculate the average readings using a calculator:

	Breakfast	Lunch	Supper
--	-----------	-------	--------

	13.2	9.9	8
	12	7.6	7
	15.4	9.5	9.1
Average values			

Which time of day was the average highest? _____

Which time of day was the average lowest? _____

OUTCOME OF DIABETES RELATED QUESTIONS

<u>Question</u>	<u>Skill tested</u>	<u>Score</u>	<u>Grade level</u>
1	Division		3
2	Addition		3
3	Fractions + graphics		4
4	Multiplication		4
5	Fractions + graphics		3
6	Rounding off		3
7	Rounding off + addition		3
8	Time and subtraction		3
9	Time and addition		3
10	Time and subtraction		4
11	Reading time		3
12	Ascending order		3
13	Descending order		3
14	Identification and grouping data		3
15	Formulae and rounding off		5
16	Multiplication		3
17	Multiplication		3
18	Multiplication		3
19	Data extrapolation from tables		4
20	Averages and calculator skills		4

OUTCOME OF BASIC MATHS QUESTIONS

<u>Section/Grade</u>	<u>Section Score</u>
<u>1</u>	
<u>2</u>	

<u>3</u>	
<u>4</u>	
<u>5</u>	
<u>6</u>	
<u>Total Score (out of 70)</u>	

SCORING SYSTEM (determined according to grade appropriate skills):

Achieved = 2

Partially achieved (needed prompting) = 1

Not achieved = 0

Total score: Basic maths skills (out of 70) =

Diabetes related questions (out of 80) =

Final Total (out of 150) =

Appendix C –Stratification of Questionnaire (Moosa & Segal, 2011)

Table 1 Basic Math skills section: Stratification of questions

Grades/ Sections	1	2	3	4	5	6
Questions (equivalent to each grade)	1-5	6-11	12-17	18-24	25-31	32-35
Scores (for each section)	10	12	12	14	14	8

Table 2 Stratification of specific sections and skills assessed

Sections /Grade	Question	Skill Assessed
1	1	Simple sequencing
	2	Word interpretation
	3	Basic Shapes
	4	1-2 digit addition
	5	Group common objects
2	1	Sequencing
	2	Basic fractions
	3	1-2 digit sums
	4	Sequencing
	5	Time
3	6	Grouping
	1	Sequencing
	2	Word sums
	3	2-3 digit sums
	4	Time conversion
4	5	Sequencing
	6	General knowledge
	1	Rounding off
	2	Descending order

5	3	Graphical fractions
	4	Double digit sums
	5	Rearrangement of sums
	6	Fractions
	7	3D diagrams
	1	Triple digit sums
	2	Sequencing and fractions
6	3	Rounding off and time
	4	Equivalent fractions
	5	Concepts (doubling/halving)
	6	Use of calculator
	7	Decimal sums
	1	Percentages
	2	Money conversion sums
	3	Interpretation: word sums
	4	Rearranging sums

Table 3 Section 2 (Applied Mathematical Questions)

Minimum grade tested	Question number	Skill assessed
Three	1	Division
	2	Addition
	5	Graphical fractions
	6	Rounding off
	7	Mixed sums
	8	Time
	9	Time
	11	Time
	12	Sequencing (Ascending order)

	13	Sequencing (Descending order)
	16	Multiplication
	17	Multiplication
	18	Multiplication
Four	3	Graphical fractions
	4	Multiplication
	10	Time
	14	Data grouping and interpretation
	19	Data interpretation
Five	15	Use of formulae and rounding off
	20	Use of calculator
	20	Averages

Appendix D- Post-test

Diabetes related questions

Question 1

If 1 CARB = 15g

Then how many CARBS in 30g? _____

45g? _____

90g? _____

Question 2

1 CARB = 1 slice of bread

= 1 fruit

= 1 biscuit

= $\frac{1}{2}$ roll

= $\frac{1}{3}$ cup rice

= 1 small yogurt

How many CARBS in:

2 biscuits + 1 small yogurt + 1 roll?

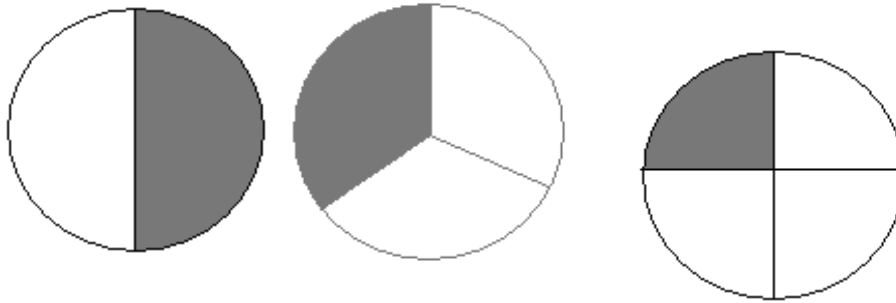
Question 3

Match the equivalent of the fraction to the picture graph:

One half ($\frac{1}{2}$)

One quarter ($\frac{1}{4}$)

One third ($\frac{1}{3}$)



Question 4

If $\frac{1}{2}$ cup cereal = 1 CARB

Then $2\frac{1}{2}$ cups of cereal equals to how many CARBS?

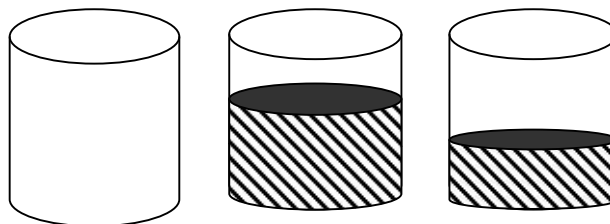
Question 5

Match the following equivalents:

$\frac{1}{4}$ can

$\frac{3}{4}$ can

1 empty can



Question 6

Round the following numbers to the nearest 10:

7 = _____

3 = _____

9 = _____

13 = _____

$17 = \underline{\hspace{2cm}}$

$18 = \underline{\hspace{2cm}}$

Question 7

Round off the following answers to the nearest even number:

6 protophane + 7 actrapid = $\underline{\hspace{2cm}}$ total units of insulin

Round it down to the nearest even number = $\underline{\hspace{2cm}}$ units

5 protophane + 6 actrapid = $\underline{\hspace{2cm}}$ total units of insulin

Round it up to the nearest even number = $\underline{\hspace{2cm}}$ units

Question 8

If bedtime is at 8pm and supper at 5pm, how many hours after supper is bedtime?

$\underline{\hspace{4cm}}$

Question 9

If a snack should be taken 2 hours after breakfast and if breakfast is at 8 am, then what time should the snack be taken?

$\underline{\hspace{4cm}}$

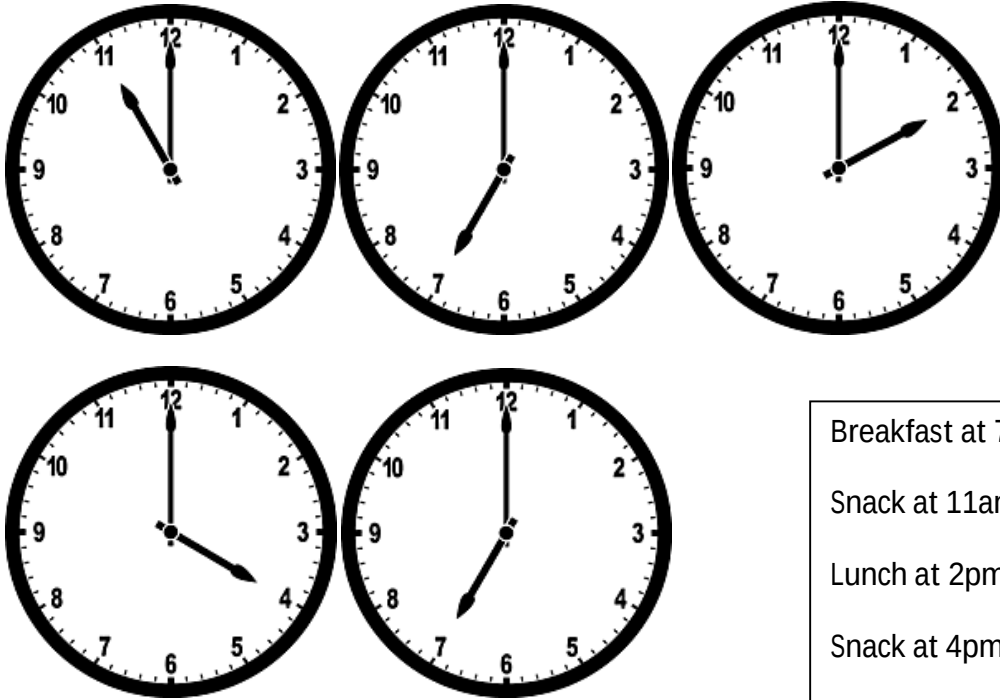
Question 10

If your insulin needs to be taken 30 minutes (half an hour) before breakfast and if breakfast is at 8am, then at what time should your insulin be taken?

$\underline{\hspace{4cm}}$

Question 11

Match the following:



Breakfast at 7am

Snack at 11am

Lunch at 2pm

Snack at 4pm

Supper at 7pm

Question 12

Arrange the blood sugar levels in ascending order (from lowest to highest):

20, 13, 22, 8, 15

Question 13

Arrange the blood sugar levels in descending order (from highest to lowest)

15, 20, 9, 30, 5

Question 14

Target blood sugar levels should be between 4 and 10. Circle the target values:

	breakfast	snack	lunch	snack	supper	Bedtime
Day 1	7	9	11	7	3	9
Day 2	23	12	5	16	15	20
Day 3	24	3	7	8	20	16
Day 4	19	8	5	12	30	10

Question 15

Work out your insulin dose using this formula:

$$\frac{\text{Formula: (Blood sugar - 6)}}{3}$$

Blood sugar = 15 then the answer is _____

If blood sugar = 12 then the answer is _____

If blood sugar = 10 then the answer is _____ Round off last dose to the nearest whole number = _____

If blood sugar = 20 then the answer is _____ Round off last dose to the nearest whole number = _____

Question 16

If you need to give 3 units of insulin every hour, after 2 hours how many units of insulin will be given?

Question 17

If you need to give 1 unit of insulin for every 10kg of body weight and if you weigh 60kg, then how many units of insulin needs to be given?

Question 18

If one fizzy drink has 12g of CARBS per 100ml. In a 300ml bottle, how many grams of CARBS are there?

Question 19

The following appeared on a chocolate bar:

	Per 100g	Per 50g serving
Protein	12g	6g
CHO	50g	25g
Fat	3g	1.5g

How many grams of Protein are there in one serving?

Question 20

The following were blood glucose readings in a diary. Calculate the average readings using a calculator:

	Breakfast	Lunch	Supper
	13.4	8	7.9
	12	6.9	3.4
	15.8	9.6	10
Average values			

Which time of day was the average highest? _____

Which time of day was the average lowest? _____

OUTCOME OF DIABETES RELATED QUESTIONS

<u>Question</u>	<u>Skill tested</u>	<u>Score</u>	<u>Grade level</u>
1	Division		3
2	Addition		3
3	Fractions + graphics		4
4	Multiplication		4
5	Fractions + graphics		3
6	Rounding off		3
7	Rounding off + addition		3
8	Time and subtraction		3
9	Time and addition		3
10	Time and subtraction		4
11	Reading time		3
12	Ascending order		3
13	Descending order		3
14	Identification and grouping data		3
15	Formulae and rounding off		5
16	Multiplication		3
17	Multiplication		3
18	Multiplication		3
19	Data extrapolation from tables		4
20	Averages and calculator skills		4

Appendix E: INFORMATION SHEET.

Date

PARENT/CAREGIVER INFORMATION SHEET- Experimental Group

Hello my name is Meagan Cronin and I am conducting research for the purpose of obtaining my Masters in Educational Psychology at the University of Witwatersrand. My area of focus is to determine whether an applied diabetes numeracy intervention program will be beneficial in improving the numeracy skills needed for a child who suffers from Type 1 diabetes to understand and self manage their diabetes. As you know diabetes is an illness where one needs to be able to keep blood sugar levels as close to normal as possible. To be able to keep one's blood sugars at a normal level it is necessary for an individual with diabetes to have basic mathematical skills and principles. Recent studies have showed that children lack basic numeracy skills that are needed to understand the basic fundamentals of diabetes and there is a lack of information on whether a numeracy intervention would improve these essential basic skills. Your child is invited to participate in this study because they fall between Grade 3 and Grade 7 and because they have been diagnosed with Type 1 diabetes.

If your child participates, the research will take place at Camp NELU. All that will be required of your child to complete a Diabetes Mathematical Questionnaire that will take approximately 30 minutes. Thereafter your child will participate in a fun numeracy intervention over the weekend that will be conducted by the researcher and the qualified camp staff during the course of the camp; this will be done at different times of the day and will be part of the camp program. Thereafter your child will complete another questionnaire based on the previous one. Participation is voluntary, and no child will be advantaged or disadvantaged in any way for choosing to participate or not participate in the study. Withdrawal from the study can be done at any stage with no negative consequences. All the results from this study will be kept confidential, and no information that could identify your child would be included in the research report. To ensure confidentiality each child will be given a study number from a list that only the chief researcher will have access to, and all the results of the study will be kept in a locked cabinet in a secure facility at the university until the end of the study or for the period of 5 years if the study is to be published, and will then be destroyed. The data may be published in scientific journals, however your child's name will be kept confidential at all times. The data will also be written up in a thesis which will be kept in the library at the University. If you wish to see the final research report and results, you can contact the researcher, who will make the findings available to them.

Your child's participation in this study will help contribute to medical knowledge that may help others with diabetes.

Kind Regards,

Ms. Meagan Cronin(Researcher)
University of Witwatersrand
Tel: 082-376-0563

Dr. David Segal/ Dr. Fatima Moosa
Research Co-Supervisors

Dr. Charmaine Gordon (Research Supervisor)
Department of Psychology
University of Witwatersrand
Tel: (011) 717 4527

Appendix E 2: INFORMATION SHEET.

Date

PARENT/CAREGIVER INFORMATION SHEET- Control group

Hello my name is Meagan Cronin and I am conducting research for the purpose of obtaining my Masters in Educational Psychology at the University of Witwatersrand. My area of focus is to determine whether an applied diabetes numeracy intervention program will be beneficial in improving the numeracy skills needed for a child who suffers from Type 1 diabetes to understand and self manage their diabetes. To be able to keep one's blood sugars at a normal level it is necessary for an individual with diabetes to have basic mathematical skills and principles. Recent studies have showed that children lack basic numeracy skills that are needed to understand the basic fundamentals of diabetes and there is a lack of information on whether a numeracy intervention would improve these essential basic skills. Your child is invited to participate in this study because they fall in between Grade 3 and Grade 7 and because they have been diagnosed with Type 1 diabetes.

Some children went on a diabetes educational camp where they were part of a numeracy intervention. I would like to find out if the intervention had any impact on their numeracy skills, in order to do this I would need to find a group of children between the same ages that could not make it to the camp. Therefore I would like to invite your child to participate, if your child participates, the research will take place at Dr. Segal's offices. All that will be required of your child to complete a Diabetes Mathematical Questionnaire that will take approximately 30 minutes. Two days later your child will complete another questionnaire based on the previous one. This will again take place at Dr. Segal's offices. Participation is voluntary, and no child will be advantaged or disadvantaged in any way for choosing to participate or not participate in the study. Withdrawal from the study can be done at any stage with no negative consequences. All the results from this study will be kept confidential, and no information that could identify your child would be included in the research report. To ensure confidentiality each child will be given a study number from a list that only the researcher will have access to, and all the results of the study will be kept in a locked cabinet in a secure facility at the university until the end of the study or for the period of 5 years if the study is to be published, and will then be destroyed. The data may be published in scientific journals, however your child's name will be kept confidential at all times. The data will also be written up in a thesis which will be kept in the library at the University. If you wish to see the final research report and results, you can contact the researcher, who will make the findings available to them. If you would like your child to participate in diabetes educational camps, there will be more camps that will be run by Dr. Segal in the future which your child will be invited to.

Your child's participation in this study will help contribute to medical knowledge that may help others with diabetes.

Kind Regards,

Ms. Meagan Cronin (Researcher)
University of Witwatersrand
Tel: 082-376-0563
.

Dr. Charmaine Gordon (Research Supervisor)
Department of Psychology
University of Witwatersrand
Tel: (011) 717 4527

David Segal/ Dr. Fatima Moosa
Research Co-Supervisors

Study: Exploring the Efficacy of an Applied Diabetes Numeracy Intervention in South African diabetic Type 1 Child Population.

PARENT/ CAREGIVER CONSENT FORM

In order to participate in this study on the efficacy of an applied diabetes numeracy intervention in a South African diabetic type 1 child population, it is necessary that you give consent. By signing this consent form you are indicating that you have read and understood the information letter attached and that you are agreeing to participate in psychological research. Please consider the following points before signing:

- Meagan Cronin has provided me with a copy of the Participant Information Sheet and Consent Form for the above mentioned clinical study and has explained to me the nature and the purpose of the study.
- I understand that my child's participation will be confidential and that all information I provide will remain confidential.
- I understand that my child's participation in research is voluntary, and that, after the research project has begun, I may refuse to allow him/her to participate without further implications.
- I understand that I may contact the researcher Meagan Cronin at 082-376-0563 should I have any questions or comments about the research.
- I understand that there are no risks or benefits attached to my child's participation in this research.
- I have understood everything that has been explained to me and I consent for my child to participate in this study.
- I understand that this research may be published in an academic journal.

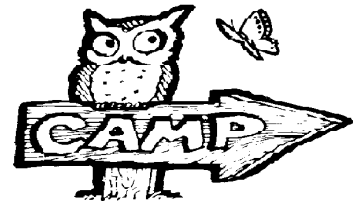
PARENT/ LEGAL GUARDIAN

Printed Name_____

Signature _____

Date and Time_____

Appendix F: PARTICIPANT (CHILD) INFORMATION SHEET- Experimental Group



Hello my name is Meagan Cronin and I am conducting research for the purpose of obtaining my Masters in Educational Psychology at the University of Witwatersrand. My area of focus is to determine whether a fun diabetes numeracy program will help to improve the numeracy skills needed for a child who suffers from Type 1 Diabetes to understand and self-manage their Diabetes. I want to see if children take part in a fun diabetes numeracy workshop whether they can better their diabetes numeracy skills, to help them manage their diabetes. At Camp NELU there will be people that are going to teach you some of the basic numeracy skills that you would need to manage your diabetes. You are invited to participate in this study because you fall between Grade 3 and Grade 7 and because you have been diagnosed with diabetes.

If you choose to participate you will be asked to answer some questions that will take approximately 30 minutes, and then you will participate in a fun diabetes numeracy activities where you will be taught the basic diabetes numeracy principles needed to self-manage, this will take place within the weekend program. After you have learnt some skills you will then be asked to answer some more questions. It will be asked from you to complete a form whereby you give permission to say that you are willing to participate in the study. You are allowed to decide whether you want to take part in this study or not. If you do not want to take part in this study you won't be treated any differently, and no harm will be done. If you do choose to participate your name will never be used, only the researcher and her teacher will see the data which will be kept at the university. You will not receive any gifts if you participate. If during the time you feel that you do not want to carry on with taking part you may stop at any time and nobody will be angry with you.

Your participation in this study will help contribute to medical knowledge that may help other children with diabetes.

Kind Regards,

Ms. Meagan Cronin(Researcher)
Department of Psychology
University of Witwatersrand
Tel: 082-376-0563

Dr. David Segal/Dr. Fatima Moosa
Research Co-Supervisors

Dr. Charmaine Gordon (Research Supervisor)
Department of Psychology University of Witwatersrand
Tel: (011) 717 4527

Appendix F 2: PARTICIPANT (CHILD) INFORMATION SHEET-Control group



Hello my name is Meagan Cronin and I am conducting research for the purpose of obtaining my Masters in Educational Psychology at the University of Witwatersrand. My area of focus is to determine whether a fun diabetes numeracy program will help in improving the numeracy skills needed for a child who suffers from Type 1 Diabetes to understand and self-manage their Diabetes. I want to see if it would help a child's diabetes numeracy if they took part in a fun diabetes numeracy workshop. Some children went on a Camp where they took part in a numeracy program, and I would like to know whether it helped to improve the numeracy skills that you would need to manage your diabetes. You are invited to participate in this study because you fall between Grade 3 and Grade 7 and because you have been diagnosed with diabetes and have not yet been to such a camp where these skills have been taught.

If you choose to participate you will come through to Dr. Segal's offices and be asked to answer some questions. This will take about 30 minutes of your time. Two days later you will then be asked to answer some more questions. It will be asked from you to complete a form whereby you give permission to say that you are willing to participate in the study. You are allowed to decide whether you want to take part in this study or not. If you do not want to take part in this study you won't be treated any differently, and no harm will be done. If you do choose to participate your name will never be used, only the researcher and her teacher will see the data which will be kept at the university. You will not receive any gifts if you participate. If during the time you feel that you do not want to carry on with taking part you may stop at any time and nobody will be angry with you. If you would like to take part in a diabetes educational camp, there will be one's run by Dr. Segal in the future which you will be invited to.

Your participation in this study will help contribute to medical knowledge that may help other children with diabetes.

Kind Regards,

Ms. Meagan Cronin
(Researcher)
Dept of Psychology
University of Witwatersrand
Tel: 082-376-0563

Dr. David Segal/Dr. Fatima Moosa
Research Co-Supervisors

Dr. Charmaine Gordon
(Research Supervisor)
Department of Psychology University of Witwatersrand
Tel: (011) 717 4527

Study: Exploring the efficacy of an applied diabetes numeracy intervention in South African diabetic Type 1 child population.



PARTICIPANT (CHILD) CONSENT FORM

In order to participate in this study on the efficacy of an applied numeracy intervention to raise mathematical abilities in a South African diabetic type 1 child population, it is necessary that you give ascent. By signing this ascent form you are agreeing to participate in psychological research. Please consider the following points before signing:

- Meagan Cronin has given me a copy of the Participant Information Sheet and Ascent Form for the above mentioned study and Meagan Cronin has explained to me the nature and the purpose of the study.
- I understand that my name will not be used in the study and that all information I give will remain confidential.
- I understand that it is my choice whether to participate in this research study, it is Voluntary.
- I understand that after the research has begun, I may choose to not participate, and if I do so I will not be treated differently in any way.
- I understand that I may contact the researcher Meagan Cronin at 082-376-0563 should I have any questions about the research.
- I understand that there are no risks or benefits attached to my participation in this research.
- I have understood everything that has been explained to me and I agree to participate in this study.

PARTICIPANT CONSENT:

Printed Name_____

Signature / Thumbprint_____

Date and Time_____

Appendix G – Basic Outline of the Intervention and Camp Timetable

The whole weekend was part of the numeracy intervention. The following diabetes numeracy areas will be covered and revised over the weekend: CARB counting, Reading food labels and tables, portion sizes, fractions, time, rounding off, blood sugar formula, averages. There were three main educational sessions that took place on the Saturday where the main areas of numeracy skills were taught. A revision of all the numeracy areas were done throughout the weekend. When everyone arrived on a Friday they were all assigned to a table and a team leader that they would work from the whole weekend (Here they checked their sugar levels, ate their food and learnt self-management skills). There were approximately 5 – 6 children in each group.

On Saturday morning from 9 am till 10.30 am, the first numeracy educational lesson took place. This was about an hour and a half long. Here the basics of diabetes were looked at and the children learnt how to work with carbohydrates. The following areas were covered:

- They learnt to check their blood sugar, and what a normal blood sugar level is. (20 min)
- What high blood sugar is? What low blood sugar is? And how one would put them in ascending and descending order. (20 min)
- They also learnt how to round off their blood sugar to the nearest whole number. (20 min)
- The children learnt how to CARB count using items of food. Each item of food is equal to a certain amount of CARBS for example a slice of bread is equal to 1 CARB, half a roll is equal to 1 CARB and a small yogurt is equal to 1 CARB. The children learnt how to add the amount of CARBS up that they ate in a day. (30 min)

To reinforce what they had learnt each of these areas were revised throughout the course of the weekend. The children checked their blood sugar levels 6 times in a full day (Friday at 21.30; Saturday at 7.30 am, 10.30 am, 13.00, 15.00, 18.30, 21.30; Sunday at 7.30am, 10.30 am, 12.30) with the doctors and nurses. Each time they tested it they rounded their blood sugar off to the nearest whole number and they needed to determine whether it's high or low. At meal times (Saturday at 8.00am, 13.30, 19.00; Sunday at 8.00, 13.00) the children got told

how many CARBS are in each food item and they needed to be able to calculate how many CARBS they are eating per meal.

The next teaching session took place between 11.00 am and 13.00 pm on the Saturday. This was two hours long. During this session the children were divided up into their grades (3-7). The participants were taught by 4 different tutors who all have tertiary qualifications. Each tutor was given a theme to teach in a specific amount of time. The children moved from one tutor to the next until their specified time at their station was up (times indicated below). The themes covered in this session were as follows:

- Time- This was taught using a readymade clock out of a paper plate- The tutors first taught the children the basics about the hands and then move on to teaching am and pm and then to hourly times. The tutor then taught the children to count in five's around the clock; once this concept had been grasped they participated in a fun activity to guess the different times given by the tutor. (20 min)
- Fractions –The children were taught how to divide areas of a shape up, such as the plate they have been using for portions and then they were given a fun worksheet that requested them to colour in specific fractional areas of different shapes. (30 min)
- Rounding off- The children learnt to round off numbers to the nearest 10 and were told how it would help them in managing their diabetes. The tutor reviewed counting in tens to 100 and then display the anthill (Appendix H). They were taught how to round off any two-digit number by putting it on the anthill. They used a two-digit number as an example and put it on the appropriate place on the ant hill. The multiples of ten that the number is between were written at the base of the ant hill, one on either side. They explained to them that they needed to look at the second number for example the 6 of 46. Then an explanation that if the number fell off the ant hill, it would fall down to the bottom of the hill on the side it was nearest. (Example: the number 46 would fall down on the side of 50 because it was closest.) The multiple of ten it falls near is the ten that number rounds to. Many more examples of rounding two-digit numbers in this manner were practised. The children then attempted doing a worksheet for additional practice. The anthill was left as a display for students to reference back to. (30 min)

- Blood sugar formulae and averages with a calculator- The children were given the formula that is used to work out their insulin dose and the tutor showed them how to apply it with examples. (30 min)

The remaining 10 minutes were for the rotation between stations. To reinforce what they have learnt each of these areas were revised throughout the course of the weekend. The children checked their blood sugar levels 6 times in a full day (Friday at 21.30 pm; Saturday at 7.30 am, 10.30 am, 13.00, 15.00, 18.30, 21.30; Sunday at 7.30am, 10.30 am, 12.30) with the doctors and nurses. Each time they tested it they rounded their blood sugar off to the nearest whole number and they determined whether it was high or low. The children gave themselves insulin three times a day (Saturday at 7.30, 13.00, 18.30 and Sunday at 7.30, 12.30) each time they worked out their blood sugar levels they needed to be able to use the insulin formula to work out how much insulin they needed to give themselves. Diabetic children need to be aware of the time so that they know when they should be checking their insulin etc. Each time the children were called together for sugar checks and snacks they were asked what the time was. (Friday at 21.30 pm; Saturday at 7.00 am, 10.30 am, 13.00, 15.00, 18.30, 21.30; Sunday at 7.30am, 10.30 am, 12.30). At meal times (Saturday at 8.00am, 13.30, 19.00; Sunday at 8.00, 13.00) the children had to work with the “fractional” portion plate to work out the different portion sizes that they were allowed to eat. They revised fractions and portion sizes every meal time.

The last educational teaching session took place between 17.00 pm and 18.15 pm on Saturday. In this session the children participants looked at nutrition and food labels. The following areas were covered:

- What is seen as good foods for diabetic children, what is seen as bad foods for diabetic children? And if they are hungry what snacks could they eat that would be good for them? (15 min)
- The children then learnt how to read nutritional labels by looking at various food labels, this taught them how to read off tables correctly and how to read for example the amount of grams of protein, carbohydrates or fat in a specific food item. The children also learnt to look at the weight of the food (in grams) for example a energy bar and compare it to the amount of grams each serving has, as a whole energy bar may have too many carbohydrates, therefore they may have to divide the bar into two. (30 min)

- The participants learnt about portion sizes. The children were given a plate that was divided up into three areas: a half and two quarter areas. The children learnt to fill half the plate with carbohydrates, fill the one quarter with vegetables and the last quarter was left for protein. During this session they also recapped CARB counting as they needed to be able to count the amount of CARBS on their plate. (30 min)

To reinforce what they had learnt each of these areas were revised throughout the course of the weekend. At meal times (Friday 19.00; Saturday at 8.00am, 13.30, 19.00; Sunday at 8.00, 13.00) the children got told how many CARBS were in each food item and they needed to be able to calculate how many CARBS they were eating per meal. The children also used the portion plate to see the amount of each food group they were eating. This was done by the group leaders during each meal time.

All the educational sessions were done by well trained facilitators and diabetic team (Dr. Segal (Paediatric Endocrinologist), Jinty Segal (Nurse), Beverly Balanco (Diabetes Educator) and the diabetes team leaders.

Welcome to CAMP!



Friday:

17:00 Arrival and the Rules



18:00 Glucose Check and injections

19:00 Supper

20:00 Number Questionnaire

20:30 Horse Making



21:30 Glucose Check and snacks

22:00 Lights out



02:00 Night Glucose Check

Sunday:

07:00 and pack

07:30 Glucose Check and Injections

08:00 Breakfast

09:00 Dodgeball

10:30 Glucose Check and Snacks

11:00 Activity with Nelu

12:00 Number Questionnaire

12:30 Glucose Check and Injections

13:00 Lunch

14:00 Home time, see you soon!

Saturday:

07:00



07:30 Glucose Check and injections

08:00 Breakfast



09:00 Education #1: The Basics

10:30 Glucose Check and Snack

11:00 Education #2: Mathematical Skills

- Rounding Off Carbs
- Food Fractions
- Working Out My Insulin Dose
- Telling the Time

Making Smart Food Choices

13:00 Glucose Check and Injections

13:30 Lunch

14:00 Race our Horses and making a flag



15:00 Glucose Check and Snack



15:30 Obstacle Course

17:00 Education # 3: Making Smart Food Choices

18:00 Free time and showering

18:30 Glucose Check and Injections

19:00 Supper

20:00 Campfire Talks

21:30 Testing, Injections and Hot Chocolate

22:00 Lights out

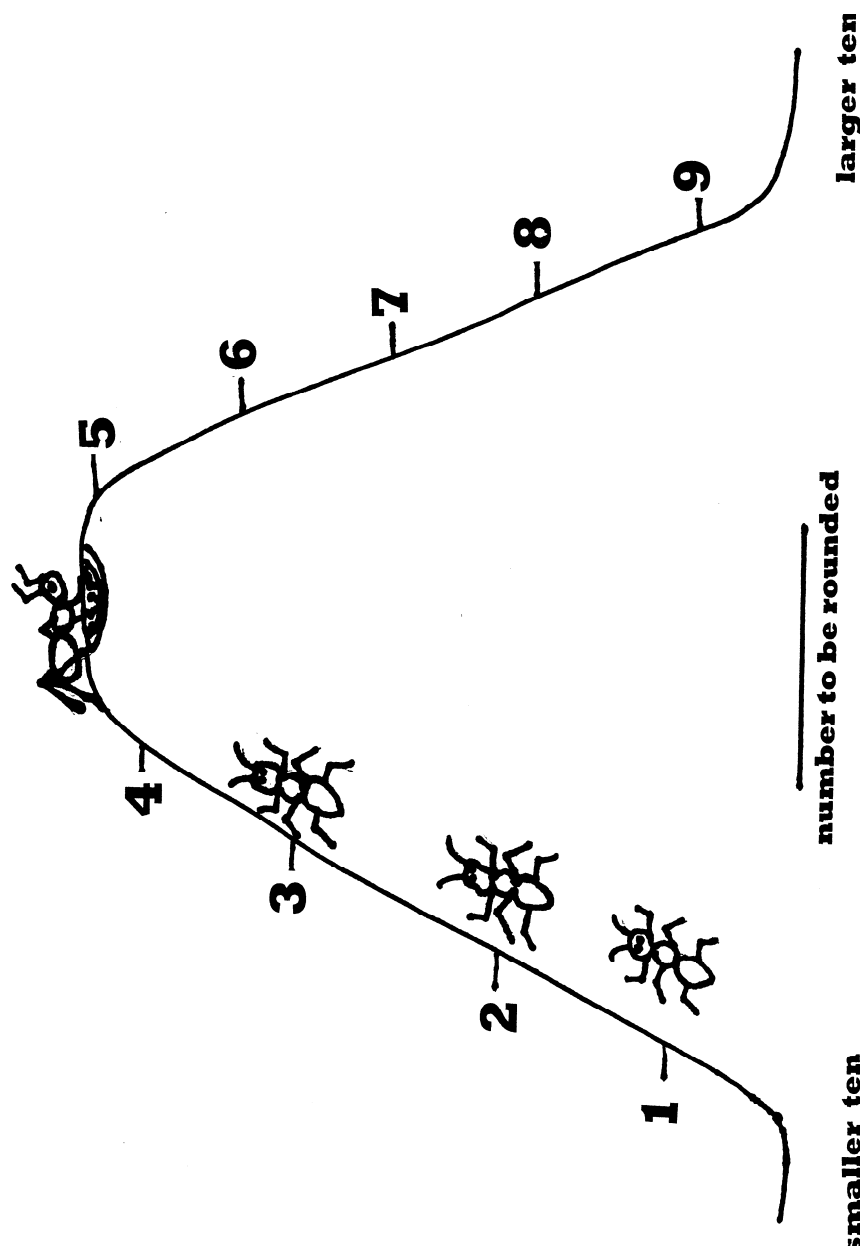
02:00 Night Glucose Check



Appendix H- Worksheets

Anthill Worksheet

Rounding-Off Anthill



Instructions for the anthill and the worksheet:

1. Tell the children they will learn to round off numbers to the nearest 10 and explain how it will help them in managing their diabetes.
2. Review counting by tens to 100 and then display the anthill above. Explain that you will show them how to round off any two-digit number by first putting it on the anthill. Choose a two-digit number as an example and put it on the appropriate place on the ant hill. Write the multiples of ten that the number is between at the base of the ant hill, one on either side. Explain to them that they need to look at the second number for example the 6 of 46. Then explain that if the number fell off the ant hill, it

would fall down to the bottom of the hill on the side it was nearest. (Example: the number 46 would fall down on the side of 50 because it was closest.) The multiple of ten it falls near is the ten that number rounds to.

3. Practice many more examples of rounding two-digit numbers in this manner. When the children seem to understand the concept, ask if there is a rule that they can make up about rounding numbers by looking at the digit in the ones place. They should be able to tell you that when the digit in the ones place is four or smaller, the number rounds to the smaller ten. If the digit in the ones place is five or greater, it rounds to the larger ten.
4. The children could then attempt doing the worksheet for additional practice. Leave the anthill displayed for students to reference.

Rounding-Off Anthill

Name _____

Directions: Look at the number and decide which two tens it is between. Write the smaller ten on the left and the larger ten on the right. Circle the ten it rounds off to. Look at the example.

Ex. 20 28 30

1. ____ 62 ____

2. ____ 19 ____

3. ____ 44 ____

4. ____ 37 ____

5. ____ 82 ____

6. ____ 56 ____

7. ____ 97 ____

8. ____ 12 ____

9. ____ 69 ____

10. ____ 49 ____

11. ____ 84 ____

12. ____ 31 ____

13. ____ 55 ____

14. ____ 78 ____

15. ____ 27 ____

16. ____ 49 ____

17. ____ 85 ____

18. ____ 91 ____

19. ____ 74 ____

20. ____ 61 ____

21. ____ 18 ____

22. ____ 26 ____

23. ____ 54 ____

24. ____ 42 ____

25. ____ 77 ____

26. ____ 99 ____

27. ____ 11 ____