Analysis of Single-Subject Research Designs in Special Needs Education: Some Examples for Application

Mwajabu Possi
University of Dar es Salaam
Mbeya College of Health and Allied Sciences
Mbeya, Tanzania
E-mail: mwajabupossi@gmail.com

Abstract

This paper is a product of a case study conducted through desk research to explore and analyse Single-Subject Research Designs (SSRDs), as applied in special needs education. The aim of the study was to generate a broad understanding of the designs in relation to special needs education and enlighten researchers on the different types of SSRDs used in the area. To realise the aim, dissertations and theses in the School of Education library at the University of Dar es Salaam and various books on SSRDs were reviewed. The paper commences by highlighting the meaning and rationale of SSRDs. It further looks into the types of SSRDs and how they are applied in special needs education. Furthermore, the paper illuminates on both internal and external validity (generalisation) when using the SSRDs and discusses on how SSRDs address the question of social validity. Strengths and weaknesses of the designs are discussed at length in the study. Further, replication of SSRDs for generalisation of data has been well stipulated. It is recommended that single-subject research designs or single-case studies be taught to majors in special needs education in higher education training institutions in Tanzania.

Keywords: Internal validity, replication, single-case studies, single-subject research designs

1.0 Introduction and background information

1.1. This paper explores and examines Single-Subject Research Designs (SSRDs) as used in Special Needs Education. The designs, also known as Single-Case Experimental Designs (SCEDs), are at times confused with case study designs because they focus on single individuals and their findings cannot be generalised

to the public. Unlike case studies, SSRDs help to investigate interventions and observe their effects on baseline behaviours (Barlow, Nock & Herse, 2009). Case studies focus on observations of events or situations that have already occurred or are currently occurring in an individual's life (Fraenkel & Wallen, 2006, p. 318). Barlow, Nock & Herse (2009), as well as Fraenkel & Wallen (2006) contend that SSRDs are common in the field of Psychology in developed nations. They are also used in Special Needs Education, especially in Applied Behaviour Analysis, to analyse behaviours of individuals with special needs.

The designs are mostly used to study changes in behaviour that an individual exhibits after exposure to an intervention or treatment of some sort. Notably, SSRDs have often been mistakenly identified with uncontrolled case study methods (McCormic, 1990; Cozby, 2004). The designs are controlled in that treatments are applied to more than one subject in a study whereby subjects serve as their own controls, hence eliminating threats to internal validity. However, such designs emphasise more heavily on functional relationship than on mere continuous observations. Ideally, researchers using single-subject designs manipulate only one variable to evaluate the functional relationship between the independent and dependent variables of a study (Hammond and Gast, 2010). Single-subject designs typically involve multiple measures of behaviour; therefore, it is important for the instrumentation to be consistent and reliable. The standardisation of data collection conditions, such as time of day, location and the observer's training, improves measurement reliability. Reliable measurement in Single-subject designs typically involves multiple measures of behaviour; therefore, it is important for the instrumentation to be consistent and reliable.

1.2. The concept of SSRDs

According to James (2016) and Kratochwill *et al*. (2010), SSRDs are research designs mostly used in psychology, education and human behaviour disciplines. In this kind of research, the subjects serve as their own control. They are more popular in the fields of special needs education and counselling. In Special Needs Education, the researcher attempts to change an individual's behaviour or that of a small group of individuals and document changes taking place. The participant serves as both the control and treatment group in SSRDs, contrary to true experiments where the researcher randomly assigns participants to a control and treatment group. In this regard, the researcher uses line graphs to show the effects of a particular

intervention or treatment. An important factor of single-subject research design is that, only one variable is changed at a time.

The unit of analysis in SSRDs is usually a single person, group of similar characteristics, a community, an organisation or a family. The design can appropriately address the question of individual differences and the extent to which data can be generalised across settings, conditions and individuals. Moreover, it can either be within subjects where each participant is his or her own control or between subject designs whereby the participant is either in the treatment or control group. Fraenkel and Wallen (2006) explain further that, though SSRDs are adaptations of the basic time-series designs, there is a difference as data are collected and analysed for only one subject at a time.

1.3. Rationale for research on SSRDs in special needs education

Research topics and methods varyingly depend on the types of issues and subjects to be studied. The variations call for diversity of research methods. According to Cozby (2004), single-case experiments were developed from a need to determine whether experimental manipulation had effects on a single research participant. In a SSRD, the subject's behaviour is measured over time during baseline control period. The manipulation is then introduced during a treatment period, and the subject's behaviour change from baseline to treatment periods signals the effectiveness of the manipulation. Horner et al. (2005) argued that single-subject designs are important and powerful methods for improving practices in the special education field for students with disabilities and their families. Single-subject designs provide methods of examining interventions for exceptional populations, such as special education students. In addition, single-subject designs may provide evidence-based results that could improve special education practices. Because single-subject designs can readily be adapted to different situations and educational settings, the designs are cost-effective. Practitioners such as clinical and school psychologists, educators of children in special needs, guidance and rehabilitation counsellors, speech therapists, as well as other practitioners who provide therapeutic interventions for clients and students normally use SSRDs. The practitioners are not interested in the generalisation of data because, what is being observed in single-subject designs is mostly behaviour, which is individualised. Moreover, there are not two organisms that emit exactly the same behaviour. Indeed, even identical twins are not exactly the same in terms of the behaviour. In fact, Wilson and Heward (1989) argue that behaviour is not a group phenomenon since it is individuals that behave and

not groups. Because the science of behaviour is concerned with the discovery of principles that govern behaviour-environment relationships, investigators wishing to learn about behaviour must analyse the behaviour of individuals, and not groups.

Barlow, Nock & Hersen (2009), Cooper (1987) as well as Johnston & Pennypacker (1980) point out that behaviour is a dynamic phenomenon, not a static event or state of the organism. Thus, single measures or even multiple measures widely dispersed over time cannot provide an accurate measure of behaviour. The measures are inadequate in terms of the task of determining the level, trend and variability of human behaviour. It is consequently important to obtain repeated measures that provide the objective estimate of the behaviour of interest. This is why Applied Behaviour Analysis researches employ various methods of event recording and time sampling through either direct observation or observation of a permanent record. Such observations are only feasible in single-subject research designs. Researchers in single-subject designs monitor range, trend, increase or decrease of behaviour through continuous observations.

In addition, Wallen *et al*. (1990) and Jackson (2015) justify single-subject research designs by drawing the researchers' attention to the fact that, at times group designs are inappropriate for a researcher to use, particularly when the usual or common instruments are not pertinent and observation must be the data collection method. Wallen *et al*. (1990) cited an example in special needs education of researchers using single-subject designs to demonstrate that the Down syndrome children are far more capable of complex learning than was previously believed. Such facts could never be available for measurements based on group comparisons with children without handicapped conditions. In other words, there are times when the study of individuals or small groups is more appropriate than larger ones. Single-subject Research Design is often used in applied and clinical settings requiring behavioural techniques.

Another factor in favour of single subject design is the one underscored by Wallen *et al*. (1990) and Jackson (2015) that, students in special needs education are of low incidence and, normally, in small numbers. In such instances, group research would be pointless. As such, the type of research requires looking into the validity of the research and techniques used rather than generalisation.

1.4 Single Subject Research Design in Tanzania

The author's experience in Tanzania higher learning institutions, particularly at the University of Dar es Salaam, confirms notes that not much has been done on SSRDs in developing nations, particularly in special needs education. An examination of research reports in the University of Dar es Salaam's School of Education library as well as lecturers' and students' dissertations and theses written from 1986 to 2018, clearly indicates the extent and application of SSRDs in the institution. Only two studies conducted using single-subject design were available in the library; a Ph. D Thesis and a consultancy report. The former is the author's PhD dissertation written in 1994 while the latter is the author's report on a research conducted through SIDA/SAREC sponsorship in 1999.

Most of the accessed researches on special needs education in the said library have been conducted through surveys using big samples and that less has been done on interventions or therapy as far as students in special needs are concerned. Furthermore, many of the studies have focused on analysing situations of people with disability mainly in teaching and learning, factors affecting inclusion and integration as well as students' academic performance. Table 1 indicates some of the purposely and strategically sampled titles of research conducted on special needs education. The author selected the studies on special needs education for the purpose of finding out the extent to which single subject research designs have been employed by education researchers in the area.

Table 1: The Available Research Reports and Dissertation on Special Needs Education at the University of Dar es Salaam's School of Education Library

SN	Research Title	Year	Design	Focus
1	The situation of students with albinism in Tanzania schools: A case study of Tanga and Dar es Salaam Regions.	1999	A case study	Education and social situation of students with albinism in schools
2.	Inclusion of disabled students in Tanzania inclusive secondary schools: Issues in pedagogical and teachers' perceptions.	2016	A case study	Inclusive and pedagogical issues
3	Attitudes of secondary school students and grade II teachers towards physical education for students with visual impairment; The case of Zanzibar West-Division of secondary education.	1998	A case study	Students with visual Impairment
4	Factors influencing the development of special education in Zanzibar	1999	A survey	General special needs education

5	An analysis of successes and challenges in the provision of inclusive education for pupils with disabilities in Tanzania primary schools: A case of Kinondoni Municipal Council, Dar es Salaam.	2016	A survey	Inclusive education
6	The Effects of Academic and Social performance of blind students in integrated and special schools in Tanzania.	1986	Survey	Delivery of education for students with visual impairment in special and integrated schools
8	Effects of money counting fluency training on the acquisition and generalization of money counting and purchasing skills by high school students with mental retardation.	1994	Single subject Research	Teaching functional skills
9	Assessing the factors influencing teaching and learning process of pupils with intellectual disability in Tanzanian primary schools: The case of Dar es Salaam Region.	2017	Qualitative research using concurrent convergent design	Classroom teaching and learning process
10	Factors affecting academic and social performance of students with visual impairment in secondary schools in Tanzania.	1996	Survey	What influences the academic and social performance of students in special needs
11	Stakeholders' conceptions of the implementation of inclusive education for learners with disabilities in Kinondoni Municipal Primary School	2017	A case study	How people interpret the implementation of inclusive education for learners with disabilities
12	Provision of Vocational skills to Learners with disabilities in Tanzania Folk Development colleges	2010	Survey	Teaching and learning process
13	Teaching social skills to preschool children with disabilities: A SIDA/SAREC funded research.	2000	Intervention study using single subject design	Applied Behaviour Analysis

Seventy research reports (100%) on education, were accessed by the researcher. Among the reports, 13 (18.5%) were on special needs education, whereby only two (2.8%) employed a single subject research design (Serial Numbers 8 and13). The two researches were intervention in nature, focusing on improving behaviours of pupils with disability. The rest of the researches were conducted using large samples for generalization. Noteworthy is that generalization in single subject research is not much understood. Could the small number of SSRDs used in the country be due to the fact that not much is known about SSRDs in terms of generalization?

Could it be the issue of Internal Validity? The fact is that results from single subject research designs can be generalized, contrary to the belief that only large samples lead to external validity or generalisation (Alnahdi, 2013; Scott, 1990). Internal validity is also taken on board in SSRDs. The assumptions on large samples can be true but cannot be taken as the rule of the thumb in special needs education, hence need for the analysis of single-subject research designs.

2. 0 Statement of the problem

Special Needs Education focuses on groups of individuals with learning and mental disability, behavioural disorders, visual, speech and hearing disability as well as health problems such as epilepsy. Gifted and talented students are also included in the group. Students in special needs differ in their severity of abilities, disabilities or special needs. Therefore, when researching on special needs education issues, special methods requiring closer observations are necessary (Barlow, Nock & Hersen, 2009). The authors also contend that, with SSRDs, the issue is intra-individual or inter-individual replications rather than group generalization. This is in line with Alnahd (2013), as well as Tanskersley, Harjusola-Webb and Landrum (2008**),** who propound that, it is necessary for educators and educational professionals to understand the characteristics of single case research methodologies as well as how they lead to effective conclusions. Given the background information, it was important to analyse SSRDs and their relevance in Tanzania's training institutions, hence this paper examining and analysing four types of SSRDs through document review.

3.0 Purpose of the study

The purpose of the research was to provide an insight into the use of SSRDs with the intention of enlightening learners and academic staff in higher learning institutions on the type of research. Specifically, the researcher looked into the types of SSRDs and how they are used in special needs education. She also worked on the validity and reliability of the designs, as well as their strengths and weaknesses. The following research questions were used in obtaining data for the study.

4 0. Research Questions

- What are the different types of SSRDs used in special needs education?
- How are SSRDs used in special needs education?
- How are validity and reliability arrived at in SSRDs?
- What are the strengths and weaknesses of the designs?

5.0 Research methodology

A Case Study Design was used to obtain a vivid and accurate understanding of SSRDs. Documentary research method was employed in collecting data on SSRDs to address the research questions. Secondary data were obtained from both printed and electronic documents i.e. books, research reports and journal articles on SSRDs. The designs were reviewed to obtain data in accordance with the research questions.

Documentary methods were applied in the study. Documents used in obtaining relevant data included publications by Jackson (2015), Alnahdi (2013), Fraenkel and Wallen (2006), Bailey and Burch (2002), Possi (2000), Possi, (1994), Bailey (1994), Wolery and Ezell (1993), as well as Barlow and Hersen (1984) and others. Further, thirteen publications on special needs education were purposefully sampled to indicate the type of studies conducted by members of staff as far as special educational needs is concerned, and the extent to which SSRDs have been employed by students and lecturers in the institution. The publications were accessed from the library.

According to Bailey (1994), as well as Bailey and Burch (2002), the use of documentary methods refers to the analysis of documents that contain information on the phenomenon one wishes to study. Payne (2004) contends that documentary method refers to a technique used to categorise, investigate, interpret and identify the limitations of physical sources, most commonly written documents whether in the private or public domain. In the same vein, Mogalakwe (2006) defines the documentary method as a technique used to categorise, investigate, interpret and identify relevant data.

5.1 Handling of documentary sources

According to Mogalakwe (2006), handling documentary sources has its own principles and that the general principles of handling documentary sources should not be different from those used in other areas of research. Similarly, Scott (1990) and Alnahd (2013) contend that data must be handled scientifically, though each source requires a different approach. The former indicated that quality control criteria for handling documentary sources include issues on authenticity, credibility, representativeness and meaning. The following are details of the criteria applied in handling documentary sources used in data gathering for the research paper.

5.1.1 Authenticity.

Authenticity is expressed in the dynamic operation of four components: awareness (i.e., self-understanding), unbiased processing (i.e., objective self-evaluation), behaviour (i.e., actions congruent with core needs, values, preferences), and relational orientation i.e., sincerity within close relationships (Goldman & Kernis, 2002). Authenticity in research depends on the validity of the research data, the reliability of measures taken to collect the data, as well as the time taken to conduct the analysis. Therefore, it was essential for the researcher to ensure continuity and objectivity throughout the research process.

The researcher made sure that the documents consulted such as published papers and electronic resources from the internet, as well as students' dissertations, published researches, etc., were from reliable sources. Sufficient time was spent in the University of Dar es Salaam's School of Education library as well as her home library reading the documents. Some of the books reviewed in the author's home library included: *Research Methods: A Modular Approach* by Jackson (2015); *Single Case Experiment Designs by Barlow* by Nock and Hersen (2009); *The Craft of Research* by Booth, Colomb and Williams (1995), as well as *Writing up Research* by Weissberg and Buker (1990) and Applied Behaviour Analysis by Cooper, Heron and Heward (2007).

The documents were handled in accordance with Scott's (1990) contention that authenticity measures whether the evidence in research is reliable and dependable. Authenticity of the evidence for analysis is the fundamental criterion in any research to ensure that the evidence is genuine and from impeccable sources. The author reviewed the sampled documents thoroughly to tap information related to single-case study designs.

5.1.2 Credibility.

According to data from Todd (2001), for a research to be credible, there has to be well-defined research questions, consistent and appropriate methodology, systematic and comprehensive literature review, sound ethical standards (including objectivity), appropriate data collection and analysis as well as evidence-based discussion and conclusion.

Appropriate questions were set to tap relevant information, targeting at the aim of the study. Literature related to the study was also reviewed. To ensure that

the documents consulted were free from distortion, reliable sources and original documents from the School of Education library, the author's home library and authentic sources from the internet as indicated in the previous sections were used.

5.1.3 Representativeness.

Representativeness or generalizability as a standard is applied differently in quantitative and qualitative research. In quantitative research, *representativeness* refers to the degree to which a study's sample can legitimately reflect or embody the broad characteristics of the population in which it is embedded. The term also refers to whether or not the documents consulted are representative of the totality of the relevant documents in addition to the extent to which the documents reviewed reflect the real situation (Payne, 2004). The researcher purposively sampled some studies conducted by students and lecturers to indicate the extent and type of SSRDs students use in their researches at the University of Dar es Salaam's School of Education. The institution was chosen because it enrols more students than other universities in the country. It was also the first university to enrol students with disability in the country. Further, the researcher searched from the internet to get papers and books on different types of single subject research designs from other countries to reflect the use of SSRDs.

5.1.4 Meaning

The term 'meaning', when used in reviewing documents, refers to whether the evidence is clear and comprehensible. The ultimate purpose of examining documents is to arrive at an understanding of the meaning and significance of what the document contains (Scott, 1990: 28). The researcher reviewed relevant documents on SSRDs and ensured that the documents represented truth and produced the actual meaning of single-subject research design.

6.0. Findings of the study and analysis

6. 1 Types of SSRDs in special needs education and how they are used

6.1.1 Types of SSRDs in special needs education

To obtain data on the types of SSRDs used in special needs education, books and research articles in both soft and hard copies were reviewed. Data indicated that five

basic single-subject research designs are mostly used in special needs education, i.e. the A-B, A-B-A, B-A-B, A-B-A-B and the Multiple-Baseline Designs.

6.1.2 How the designs are used in special needs education

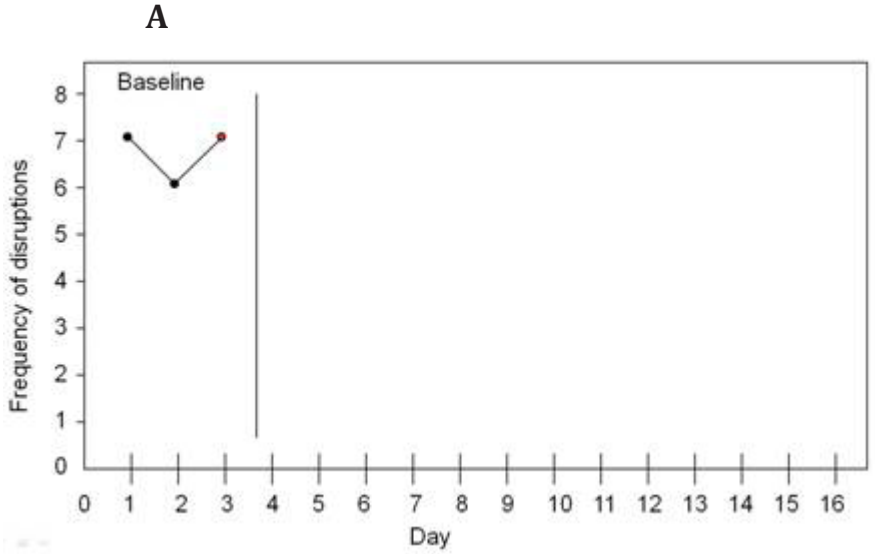
Data on the types of SSRDs used in special needs education were reviewed and analysed. The use of the designs is discussed in the following subsection, using scenarios of typical behaviours in the day-to-day classroom teaching of students with special needs.

6.1.2.1 The A-B design

According to Cozby (2001), the A-B design is the simplest form of SSRDs. It is a baseline (Treatment) model which can be used to minimise unwanted behaviours such as a student's out of seat behaviour in the classroom. Repeated measures are necessary for this type of research before embarking on a treatment, as well as during the treatment phases. After such measures, a comparison is made to draw conclusions. It can, for instance, be used to end students' disturbing behaviours, including what they exhibit in classrooms as indicated in scenario 1:

Scenario 1:

Mohammed is a student in the 7th grade in an inclusive classroom. He has a very low concentration span due to his extreme disruptive behaviour as indicated in Figure 1.



Source: Modified from Todd, T. J. (2001). Summary of Basic Single Subject Design

Types: http://www.baam.emich.edu/baamdownloads/baamstudyguides/singsub.pdf Accessed on 4th August, 2018

Data from the Figure 1 show that within three days, Mohammed has been disrupting other students in class for at least twenty times (Stage **A**). After noticing this disruptive behaviour, the class teacher explains the situation to the pupil's mother and later on recommends the student to a special needs teacher, who is also a behaviour analyst. The class teacher, in consultation with the behaviour analyst, decides that Mohammed should be given treatment to enable him spending 40 minutes in class without disrupting other students. Furthermore, the teacher and the behaviour analyst recommend that Mohammed be provided with a treatment of praise when he concentrates in class without disturbing other students. Mohammed's behaviour is observed through AB design from Monday to Friday as indicated in Figure 2.

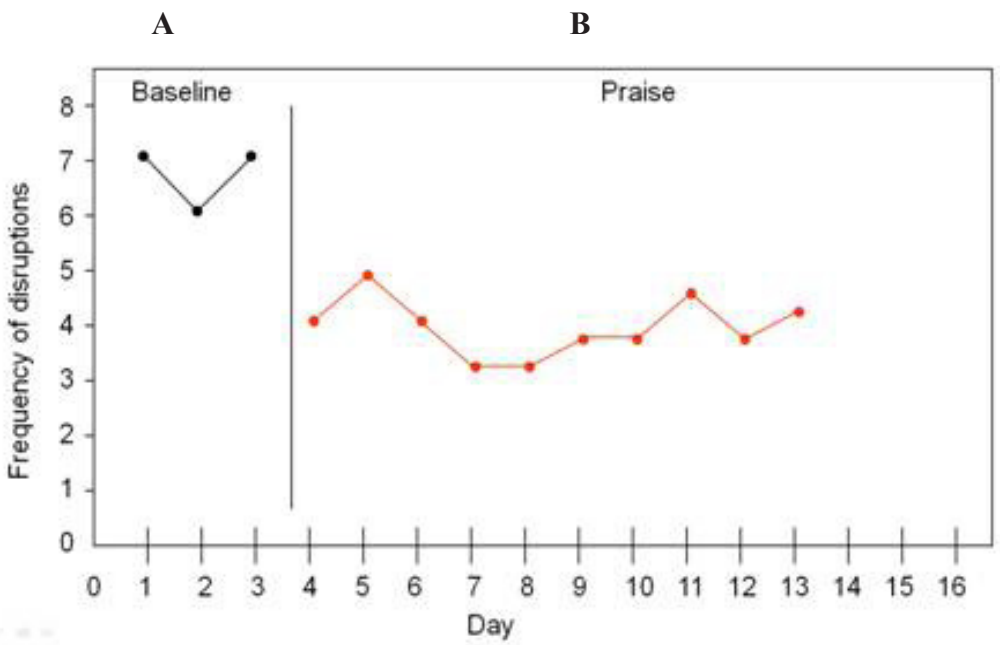


Figure 2: A Hypothetical AB Graph of Mohammed's Disruptive Behaviour in an English Language class

Source: Modified from Todd, T. J. (2001). Summary of Basic Single Subject Design Types; http://www.baam.emich.edu/baamdownloads/baamstudyguides/singsub.pf

Accessed on 4th August, 2018.

In the post-treatment period in stage B, the graph indicates that the student's disruptive behaviour has decreased to around 40 percent to 50 percent and that the highest disruptive behaviour was five times. From the graph, one learns that the A-B design can facilitate the quick assessing of the effects of an experimental variable.

In the intervention just highlighted, Mohammed received a verbal reinforcement, which culminated in an increased level of concentration in his work. This made his out-of-seat behaviour to decrease, meaning that the contingent reinforcement had worked. On the other hand, it is difficult to distinguish the experimental effect from possible confounds from the design. What one may not know here is whether or not there were other variables that led to increase in the student's sitting and concentration span in the classroom or that the increase was due to a combination of other possible factors. Such a situation calls for another observation, hence the A-B-A reversal design as indicated in Figure3 in the following subsection.

6.1.2.2 The A-B-A reversal design.

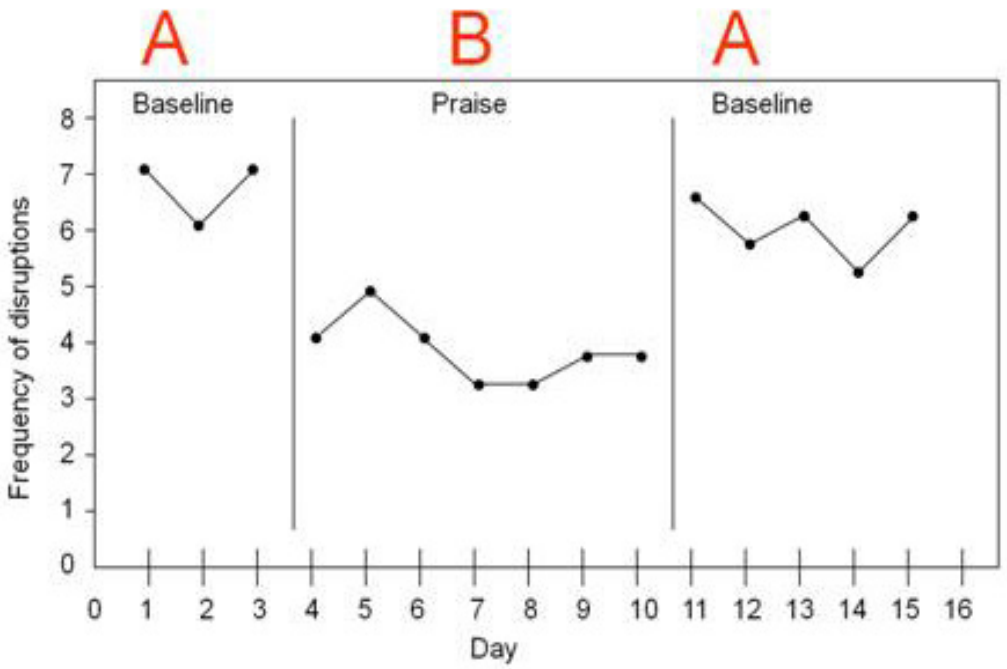


Figure 3: The A-B-A reversal design

Source: Modified from https://saylordotorg.github.io/text_research-methods-in-Psychology/s14-02-single-subject-research-design.html. Accessed on 4th August, 2018.

In an A-B-A reversal design, there is no treatment given and/or no variable is introduced during the baseline (A), followed by a period in which the treatment or variable is introduced (B), and subsequently a period in which the treatment is removed so that the behaviour can be observed for the second time (A). Thus, one can measure behaviour before, during, and after treatment.

In relation to Mohammed's behaviour, the teacher observed, gave treatment, and reversed to the baseline phase to enable him confirm whether it was the treatment that had brought about the student's behaviour change. The teacher had to compare the data emanating from the baseline stage (A) and treatment stage (B) by returning to baseline stage (A) as indicated in Figure 2. The graph is elaborated in phases as indicated in the following descriptions**.**

For data reliability, it was important to observe the stability of Mohammed's behaviour (Phase A) and obtain the relevant data to guide the teacher on treatment in Phase B. The teacher anticipated the decrease in the eruptive behaviour because of the withdrawal of treatment. However, that was not the case. The behaviour was observed to be as poor in the initial stage the treatment provided notwithstanding. If Mohammed continued to have a better concentration span without eruptive behaviour in the last phase it could be said that the treatment had been effective. However, there was need for more observation.

The teacher withdrew the treatment and went to the baseline phase (A) in order to determine the trend of the disruptive behaviour through another observation. The teacher observed Mohammed and recorded the incidences of his disruptive behaviour after every 15 minutes (interval recording) to find out the number of times he was disruptive and not actually sitting on his chair or moving around unnecessarily.

The teacher anticipated the decrease in the eruptive behaviour because of the withdrawal of treatment. However, that was not the case. In fact, it was as bad as in the initial stage despite the treatment provided. If Mohammed had continued to have a better concentration span without eruptive behaviour in the last phase, it could be said that the treatment had been effective. Data indicate that the student continued with the behaviours, leading to the scaling up of disruptive behaviour. It can, therefore, be concluded that the intervention measures did not work for the student. The results call for further consideration on the kinds of intervention to be used to reduce the disruptive behaviour.

From the student's observed behaviour and the results obtained, the next intervention could be through the use of the B-A-B design. However, with some behaviour in special needs education, one cannot start with a baseline as it was the case in the previous experiment. All in all, there are instances when behaviour has to be immediately intervened, such as self-injury, hence the use of the B-A-B design. The following paragraphs contain elaborations on the design.

6.1.2.3 The B-A-B design

The interventions used for the B-A-B design are discussed using the following hypothetical example:

Ame is a Standard I pupil with self-injurious behaviour. He is very disruptive and keeps other pupils sitting close to him to be nervous and uncomfortable. No student interacts with him. Having seen Ame's behaviour, the teacher decides to take action before the behaviour worsens. She decides on the treatment to be used and begins with the B-A-B reversal design treatment straightaway. According to Tawney and Gast (1984), teachers and clinicians frequently use the designs with students who exhibit self-injurious or physical aggression behaviours. Figure 3 exemplifies the B-A-B the reversal design used for intervention:

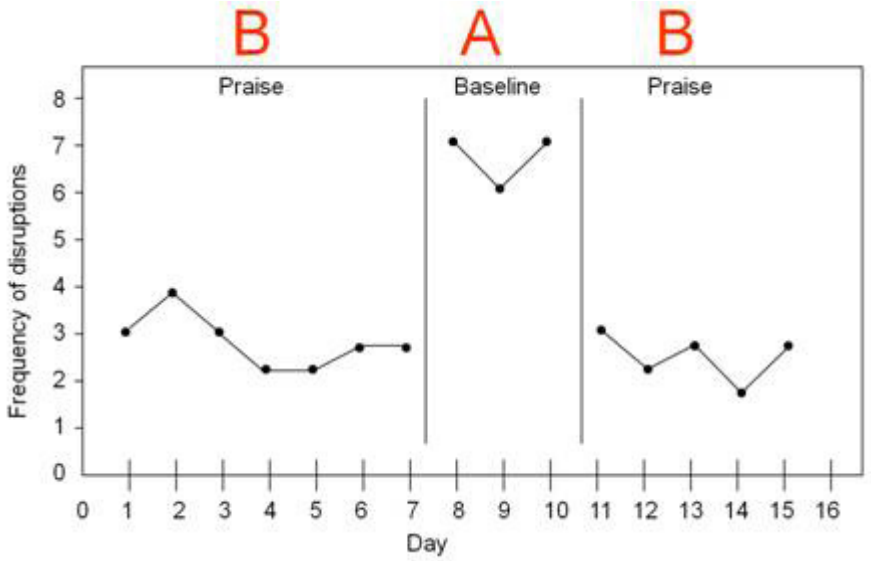


Figure 3: B-A-B reversal design

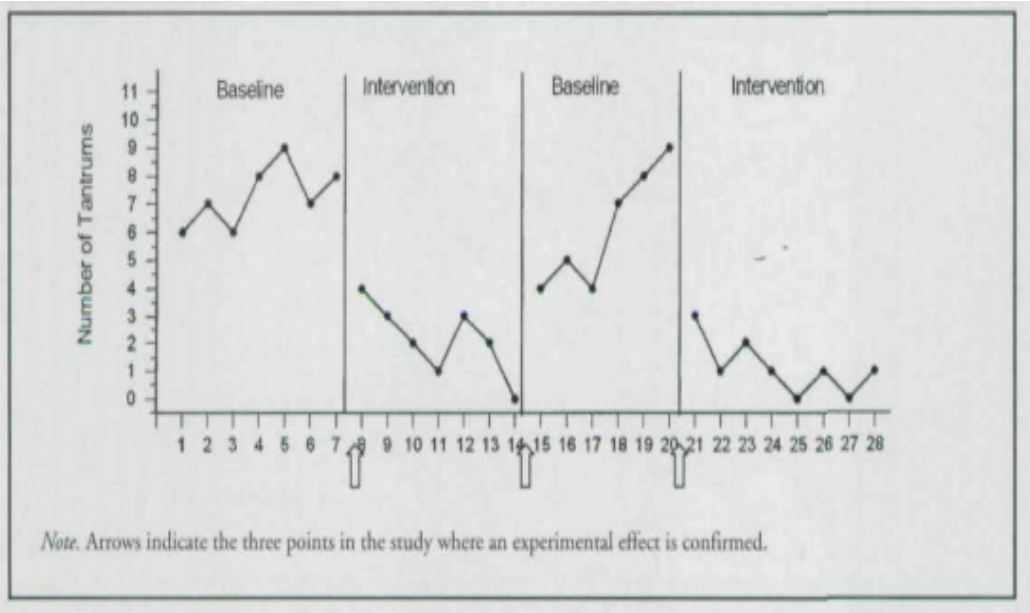
Source: Modified from http://open.lib.umn.edu/psychologyresearchmethods/chapter/10- 2-single-subject-research-designs/ Accessed on 4th August, 2018.

Since the teacher had observed that Ame engaged in the behaviour 10 minutes

before break, she decided to provide contingent attention at that time. The teacher believed that if the initial treatment indicated stable changes toward a desirable behaviour, she would stop the treatment and observe Ame to find out whether the behaviour would reoccur or decrease. As the behaviour continued, the teacher returned to A, where no praise was given. The teacher observed that the disruptive behaviour had increased (See Figure 3). Notably, there was an introduction and withdrawal of the experimental variable. The teacher could extend the use of the A-B-A design. The design could have irreversible effects, despite its advantage of ending up with a treatment and allowing the demonstration of intervention effectiveness (Tawney & Gast, 1984, p. 216). The authors, however, advise that where ethical and practical considerations permit, a more reliable demonstration of causality is possible with A-B-A-B design. The following paragraphs discuss the A-B-A-B design as indicated in Figure 4:

6.1.2.4 A-B-A-B reversal design

With the A-B-A-B reversal design presented in Figure 4, the behaviour (A) in the baseline is measured first, followed by a treatment measurement (B), then the observation or withdrawal of treatment (A) and, finally, the second treatment (B). The A-B-A-B design requires repeated measures which require steady observation and treatment and measuring changes in behaviour. According to Cooper, Heron and Heward (2007), the design is the most straight-forward and generally the most powerful within-subject design for demonstrating a functional relation between an environmental manipulation and a behaviour. When a functional relation emerges during a reversal design, the data show how a behaviour works as Figure 4 demonstrates:



S*ource*: Downloaded from http://open.lib.umn.edu/psychologyresearchmethods/wp-content/uploads/sites/171/2015/07/ Accessed on 4th August, 2018.
Figure 4: A-B-A-B reversal design.

In summary, a baseline condition is followed by an intervention condition, then by a return to baseline condition and, finally, by a return to the same intervention condition for confirmation of the validity of an intervention. It offers replication of the A-B design.

6. 1.2.5 Multiple baseline design

According to Geisler, Hessler, Gardner and Lovelace (2009), the type of design involves multiple persons, traits or settings which also involve careful measurements before and after treatment. Medical personnel, behaviourists, behavioural psychologists and other specialists, use this type of Multiple-baseline design, which does not require the withdrawal of the intervention. Instead, each result in each subject acts as his or her own control. Instead of waiting until the post-intervention period to take measures on the behaviour, single-case research prescribes continuous data collection and visual monitoring of the data displayed graphically, hence allowing for immediate instructional decision-making. Students, therefore, do not linger on in an intervention that is not working for them, hence making the graphic display of single-case research combined with differentiated instruction responsive to the needs of students. Figure 5 presents the design:

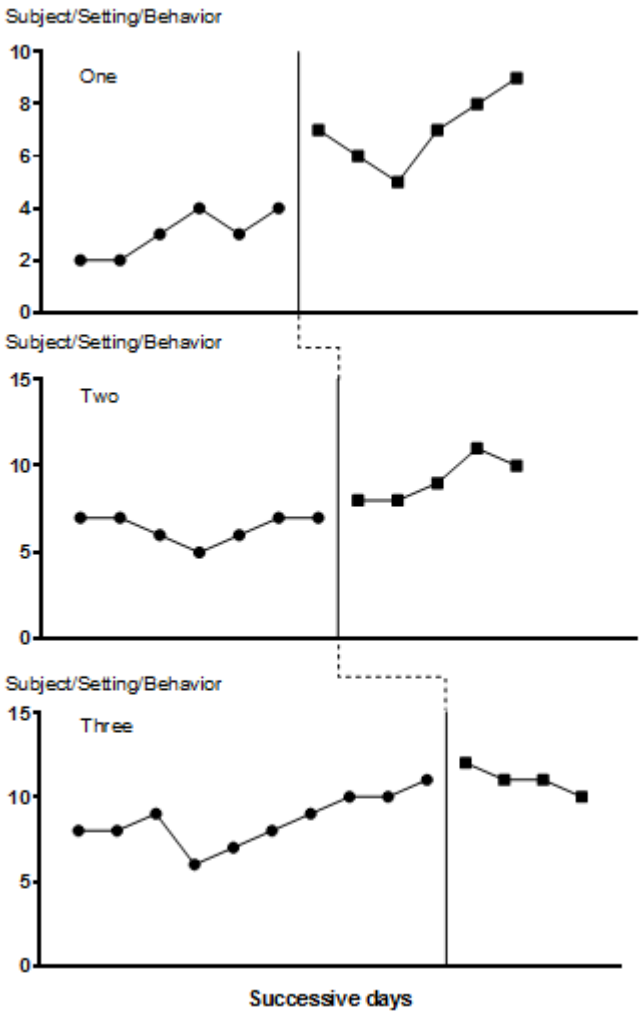


Figure 5: Multiple baseline design
Source: https://www.google.com/search?q=reversal+design**. Accessed on 4th August, 2018**

The designs are most commonly used in cases where the dependent variable is not expected to return to normal after the treatment had been applied, or when medical reasons forbid the withdrawal of a treatment. They often employ particular methods or recruit participants. Multiple base-line designs are associated with potential confounds introduced by an experimenter bias which must be addressed for objectivity. Researchers are advised to develop all the test schedules and data collection limits beforehand (Christ, 2007).

There are other multiple-treatment designs such as A-B-A-C and A-B-A-C-A-D, whereby researchers may determine with more certainty the extent to which each treatment affected their dependent variables. However, re-establishing baseline after each treatment condition may be time-consuming, which could also depend on the resources at the disposal of researchers (e.g., Cooper et al., 1987). Similarly, with an A-B-C-D design, for example, researchers may study multiple treatments in less time, but carryover or order effects may make it difficult to determine how each treatment in isolation affects the dependent variable. Ultimately, the type of multiple-treatment design that researchers choose to use in their respective studies may depend on the specific purpose of their study.

According to Cooper, Heron and Heward (2007), the multiple baseline designs are useful in interventions that they are irreversible due to learning effects and when treatments cannot be withdrawn. In such designs, behavior is measured across multiple individuals, behaviors, or settings. The multiple designs, like reversal designs, start with the baseline (phase A), then proceeds with the intervention (phase B). However, return to the may not be necessary to demonstrate the effect of treatment. Instead, the treatment is applied to another person (as in the graph above), another behavior, or another setting, depending on the variable being manipulated.

6.1.3 Validity and reliability in SSRDs Validity in SSRDs.

Specialists/scholars in SSRDs are always concerned with their subjects in terms of social validity. Basically, the issue in single-case experiments has to do with determining whether the manipulation of the independent variable has had an effect. Therefore, there has to be a demonstration of reversibility of the manipulation. According to Barlow, Nock and Herse (2009), validity involves the extent to which the data represent the phenomenon being assessed. High validity occurs when the data obtained closely compare with other measures of the phenomena, especially when other measures have well-established validity themselves.

Cozby (2001) explains that validity refers to truth and the accurate representation of information. Therefore, researchers should be concerned about the appropriateness of their studies. As such, whatever study one is engaged in should be relevant and meaningful to the targeted group. Any research that is not user-friendly or is unuseful to the consumer reflects failure on the part of the researcher. On the other hand,

the appropriateness, meaningfulness, and usefulness of the inferences a researcher makes is what constitutes validity (Wallen *et al*., 1990). Tawney and Gast (1984) contend that validity is a critical concern for any study. Consequently, the best question to ask in SSRDs in terms of validity is whether or not the treatment used in the study is appropriate to the subject in a given situation.

Cooper, Heron and Heward (1987) argue that, a valid experiment has to show convincingly that changes in the target behaviour are a function of the independent variables and not as a result of uncontrolled or unknown variables, and that the study results should be generalizable to other subjects, settings, and/or behaviours. The authors define validity as a functional relation between socially-significant behaviour and socially-valid treatment. Knowledge of functional relations enables the behaviour analyst to alter reliably important behaviour in meaningful ways. Tawney and Gast (1984) outline two validity issues that are important in single subject research: internal and external validity**.**

Studies involving single-subject designs that show a particular treatment to be effective in changing behaviour must rely on "replication–across individuals rather than groups–if such results are be found worthy of generalization" (Fraenkel & Wallen, 2006, p. 318). The following paragraphs describe validity and how it can be realised in single-subject research design

6.1.3.1 Internal validity

Cozby (2001) refers to internal validity as the ability to draw conclusions about causal relationships from our data. The author contends that a study has high internal validity when strong references can be made that one variable caused change in the other variable. On the other hand, Cooper *et al.* (1987) define internal validity as the demonstration that the measured changes in the target behaviour occurs because of experimentally manipulated changes in the environment and that the changes are a function of independent variables and not occurring as a result of the uncontrolled variable. The authors also state that a study without internal validity can yield no statements regarding the functional relations between the variables examined in the experiment, nor can it serve as a basis for any statements regarding the generality of the findings to other subjects, settings, and/or behaviours. This statement is supported by Cozby (2001) who contends that internal validity increases when the considerations of the cause and effect that have been previously discussed can be applied to the research. Therefore, internal validity is arguably a prerequisite for external validity.

Internal validity in single-subject research is obtained through repeated measures which can control invalidity and take care of threats to internal validity such as maturation. Internal validity in such research is maintained through repeated measurements done using different designs, with each behaviour acting as its own control. In short, validity basically refers to whether or not the intervention is the only cause of the change of a client's behaviour.

6.1.3.2 Generalisation of single subject research/ external validity

Cozby (2001) defines *external validity* as the extent to which the results are generalizable to other populations. The author contends that such validity deals with the question of how the results can be replicated with other operational definitions of the variables, how they can be replicated with different research participants, or in other settings. In the same vein, Jackson (2015) asserts that the term refers to how research results can be generalised beyond the subjects used in the experiment as well as beyond the laboratory in which the experiment was conducted. On the other hand, McCormick (1990) proffers that external validity is the strongest opposition to single-case experimental methodology. The opposition arises from a controversy about the appropriateness of the generalization of results based on a small non- randomly selected sample. It was from this argument that the researcher had to review how other researchers discuss external validity or generalisation.

The studies reviewed have indicated that generalisation in single-subject research is obtainable through replication, for example, the repeating a previous experiment (Gay, 1987). Johnston and Pennypacker (1980) define replication as the "reproduction that is used to denote duplication of the dependent effect, thus one replicates procedures in an effort to reproduce effects" (pp. 303-304). It may also be a repetition of the original study using the same or different subjects, or representing an alternative approach to testing the same hypothesis. Repeating the study with different subjects in different settings increases the generalizability of the findings.

On the other hand, Sidman (1960) provides two types of replication in a single-subject design: direct and systematic replication. Direct replication involves duplicating the exact conditions of a previous research or experiment. It can be intra-subject whereby the same subjects are used. For inter-subject replication, every aspect of the previous experiment is maintained with the exception of

different although similar subjects. For example, if a previous experiment involved teaching polite Kiswahili words to ten 5th graders with mild mental retardation in elementary school, when requesting for and appreciating something, i.e teaching the words *please* and *thank you,* the next study might be carried out in the same school with students of the same characteristics and under almost similar experimental environments. If the results of the study correlate with the previous ones, it can be proved that there is external validity. Many experiments carried out in special education involve inter-subject replication more than intra subject replication because it is difficult to carry out intra-subject experiments. In this regard, Cooper, Heron and Heward (1987) contend that generality is feasible only through inter subject replication.

In addition, Birnsbrauer (1981) asserts that "external validity can be pursued only through active process of systematic replication" (p.122). The replication is defined as repeated experiment in which the conditions of interest are purposefully and systematically varied. Any aspect of the replicated experiment can be slightly changed, for example, subjects for a given study, setting, administration of the independent variable, target behaviours. For example, one can study the effect of token reinforcement on reading achievement of students with moderate mental retardation and then replicate it using students with mild mental retardation, etc. The generality of a given treatment is enhanced when it produces similar results. Successful reproducing of results of previous research does not only demonstrate the reliability of the findings but also adds to the external variability of the treatment effect by showing that it can be obtained under varying conditions.

Replication is necessary in science but it is not easy to carry out. McCormick (1990) observes that the number of repetitions for generality to be established in single-subject research depends on the complexity of the problem, the magnitude of the effect, the obviousness of the findings and other factors. Simply put, replication demonstrates reliability and generality of data. It reduces margin error while boosting confidence that the results from the repeated tests are real not accidental.

Campbell and Stanley (1963) contended that generalisation deals with external validity. To what population, setting, treatment, and measurement variables can the effect be generalised? On the other hand, Sidman (1960) opposed the traditional question of generality by raising the following question: "How representative of the total population, if all its members could have been exposed to one or the

other of the values of independent variable?" (p. 49). He further argues that we cannot dispose of the problem of subject generality by employing large groups of subjects and using statistical measures, such as the mean, and variance of the group. After all, it is not necessarily true that the larger the group, the greater the generality of data. In fact, representativeness is the actuarial problem to which the currently prevalent statistical design is not applicable (Sidman, 1960, p. 47). Fisher (1956) shares the same view by contending that proper inference that can be made from group design study is from the sample to the population and not from the sample to the individual. Furthermore, Cooper (1982) argues, "Indeed the better the sample represents the population from which it is drawn, the less meaningful are the results from any individual subject." These arguments render credence to the fact that what matters in generalisation is not a large sample but replication.

6.1.3.3 Social validity.

SSRD specialists/scholars are always concerned about their subjects in terms of social validity. According Foster and Mash (1999), social validity refers to the acceptability of and satisfaction with intervention procedures, usually assessed by soliciting opinions from the people who receive and implement them. Social validity is a term coined by behaviour analysts to refer to the social importance and acceptability of treatment goals, procedures, and outcomes. The intervention procedures for child behaviour are socially valid when people judge them as being acceptable (ibid.). Moreover, Kennedy (2002) posits that social validity assessment requires questioning the recipients of intervention and the individuals responsible for procedural implementation. For example, a child who receives a school-based intervention might be asked about the appropriateness of the procedures a classroom teacher deploys (e.g., did they make the student "stand out" among other students?).

7.0 Strengths and Weaknesses of Single-subject Research Designs

Having discussed the validity and generalisation of single-subject research, it is worthwhile looking at their strengths. The documentary review has indicated the following strengths and weaknesses of SSRDs based on insights from Tanskersley, Harjusola-Webb, and Landrum (2008) and Alnahd (2013).

7.1 Strengths

- Through SSRDs, it is easy to see the amount of improvement through the treatment trials and also to see decrease, increase, maintenance and/or generalization of behaviour.
- Variability measure is easily realised in SSRDs.
- The repeated and frequent measurements of the same variable during intervention enables researchers to identify trend, fluctuations or variability as early as possible hence keeping the researcher informed on all the changes.
- Repeated measures of baseline serve as a control as well as a criterion for future performance of the subject.
- The immediate plotting of data allows for a quick review of the trend of the behaviour to be changed; therefore, it may be easy for an experimenter to change some of the aspects of the study if the experiment goes astray or sees the need for change.
- SSRDs have high internal validity primarily because the researcher is interested in the variability of the changes taking place.
- The designs can be applied in clinical and classroom settings with emphasis on therapeutic measures, which are the main goal for special education.
- With SSRDs it is easy to conduct a scientific investigation using even one subject.
- SSRDs are highly flexible showing individual differences in response to intervention effects.

7.2 Weaknesses

7.2.1 History.

According to Alnahd (2013), SSRDs have several weaknesses or disadvantages, which include the following:

- The subjects' behaviours are affected by history of occurrence of events that are not part of the experimental treatments but affect the research. Several causative events include the closure of a school due to epidemics, for example, those caused by the outbreak contagious diseases such as flu, outset of severe rains, severe winters or storms, shortage of equipment. These factors can affect the research. For instance there can be cholera in certain areas where schools may be closed, making it difficult for research participants to be available

7.2.3 Maturation

- Since the design requires a long-term observation, physical or mental changes may occur within the subject over a period. The changes may affect the measurement of the dependent variable. For example, teaching a child with severe mental disability to use the toilet may be affected by maturation if training takes time and the child responds to the same test repeatedly. His/her improvement might not be due to the training as such but due to his/her having excess training. Thus, it is difficult to tell whether or not the improvement was a result of the experiment.

7.2.4 Testing

- Subjects' scores may improve during the baseline, hence making it difficult for the researcher to determine whether or not the changes result from the experiment or not.

7.2.5 Instrumentation

- Instrumentation effect occurs when there are changes in measuring devices or when human observers tire or get bored and fail to observe the same event. This is the side effect of continued observation for a long period.

7.2.6. Attrition/mortality/loss of subjects.

- Some subjects may be transferred or fall sick and decide to drop out from the study, or some parents may decide that they do not want their children to participate in the study.

7.2.7 Multiple intervention interference

- If same subject receive multiple interventions or multiple "treatments" there can be interference. For example, if a hyperactive child is under medication (sedatives) while under the reinforcement schedule for behaviour change, it will be difficult to tell which of the treatments would have caused the change.

7.2.8 Instability

- It is difficult to demonstrate whether the effect is strong or stable when there is variability of the occurrence of behaviour. As such, one has to wait

for stability and entails intervening when the behaviour is likely to change naturally. In this regard, an example can be drawn from a student who is disruptive to others, with fellow students avoiding him. If at this time of avoidance the teacher introduces an intervention and the students know how to bear with him/her, and his/her behaviour returns to normal, it will be difficult to establish whether it was the intervention or adaptation of the process.

7. 2. 9. Irreversibility.

In some withdrawal designs, once a change in the independent variable occurs, the dependent variable is affected and this cannot be undone by simply removing the independent variable.

7.2.10 Ethical problems

Withdrawals of treatment in the withdrawal design can at times present ethical and feasibility problems.

7.2.11 Practical limitations

Single-case design is time consuming. In fact, it generally takes several fortnights or months to complete whereas much large end research design can be carried out in only one session.

7.2.12. Generalisation

The conclusions obtained from SSRDs are difficult to be generalised to other participants due to individual differences and sample size.

8. 0 Summary, Conclusion and Recommendations

8.1. Summary and conclusion

This paper has attempted to conceptualise and discuss SSRD and its importance in special needs education. Both internal and external validity have been dealt with in-depth. The strengths and weaknesses of single case design are important in special education, which deals with groups of low incidence and that the subjects serve as their own controls. In fact, validity and generalisation are achieved through replication. Overall, the application of observational methods is easy to apply and follow.

8.2 Recommendations

It is recommended that single-case design be taught in all higher learning institutions to students in education, especially those majoring in special educational needs and psychology. Moreover, research institutions should strengthen their research courses to include single-case design and encourage students to conduct research using SSRDs. Furthermore, lecturers in Educational Psychology and those in general psychology should collaborate and conduct single-subject research to assist students with disability, or psychological problems.

References:

Alnahdi, G. H. (2013). Single subject designs in special needs education: Advantages and limitations. *Journal of Research in Special Educational Needs*, *15*(4), 1-4.

Bailey, J. S. & Burch, M. R. (2016). *Ethics for Behaviour Analysis*, 3rd Edition. New York: Routledge.

Bailey, K. (1994). *Methods of Social Research*, 4th Edition, New York: The Free Press,

Barlow, D. H., Nock. M. K. & Herse, M. (2009). *Single Case Experimental Designs: Strategies for Studying Behaviour Change*. 3rd Edition. Boston: Pearson Education, Inc.

Birnbrauer, J. S. (1981). External validity and experimental investigation of individual behaviour. *Analysis and Intervention in Developmental Disabilities, (1), 117-132. Single case experimental designs. Strategies for studying behavioural change*, 3rd Edition, Boston: Pearson

Booth, W. C., Colomb, G. G. & Williams, J. M. (1995). *The Craft of research*. Chicago, IL: The University of Chicago Press.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi experimental designs for research.* Boston: Houghton Mifflin Company.

Christ, T. (2007). Experimental control and threats to internal validity of concurrent and non-concurrent multiple baseline designs. *Psychology in the Schools*, 44 (5), 451-459

Cooper, J. O., Heron, T. E & Heward, W. L. (2007). Applied behaviour analysis (2nd Ed.). Upper Saddle River, NJ: Prentice Hall.

Cooper, J. O., Heron, T. E & Heward, W. (1987). *Applied behaviour analysis*,

Columbus: Merrill Publishing House.

Cooper, J. O. (1982). *Applied behaviour analysis in education*: *Theory into Practice XXI, (2) 114-118.*

Cozby, P. C. (2001). *Methods in behavioural research*. Boston: McGraw Hill.

DePoy, E. and. Gitlin, L. R. (2016). *Introduction to research, 5th Edition)*. Elsevier: Inc. USA Maryland.

Erlbaum, L. & Kennedy, C. H. (2002). The maintenance of behaviour change as an indicator of social validity. *Behaviour Modification, 26*, 594–604.

Fisher, R. (1956). *Statistical methods and statistical influence*. London: Oliver & Boyd.

Fraenkel, J. R., & Wallen, N. E. (2006). How to design and evaluate research in education (6th Ed.). New York, NY: McGraw-Hill Publishing Company

Fraenkel, J. R., & Wallen, N. E. (1990). *How to design and evaluate research in education,* New York: McGraw-Hill Publishing Company**.**

Foster, S. L. & March, E. J. (1999). Assessing social validity in clinical treatment Research. *Journal of Consulting and Clinical Psychology, 67 (3),* 308-319.

Gay, L.R. (1987). *Education research: Competence for analysis and application*. New York: Merrill Publishing House.

Geisler, J. L., Hessler, T., Gardner, R., III, & Lovelace, T. S. (2009). Differentiated writing interventions for high-achieving urban African American elementary students. Journal of Advanced Academics, 20, 214–247.

Goldman, B. M., & Kernis, M. H. (2002). The role of authenticity in healthy psychological functioning and subjective well-being. *Annals of the American Psychotherapy*

Association, 5, 18 -20 Retrieved June 8, 2019, from https://doi.org/10.1177/1053451208321600

https://www.slideshare.net/.../credibility-validity-reliability-and-transferability. Retrieved June 8, 2019.

Jackson, S. L. (2015). *Research methods: A modular approach*. Stamford: Engaged Learning.

James, K. P (2016). Single-subject research method: The needed simplification. *British,* 4 (6), 68-95.

Johnston, J.M., & Pennypacker, H.S. (1980). *Strategies and Tactics for Human Behavioural Research.* Hillsdale, New Jersey:

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M. & Shadish, W. R. (2010). *Single-case designs technical documentation*. Retrieved from http://ies.ed.gov/ncee/wwc/pdf/wwc_scd.pdf Accessed on 10th August, 2018.

McCormick, S. (1990). A case for the use of single subject methodology in reading research. *Journal of Research in Reading, 13 (1), 61-81.*

Mogalakwe, M. (2006). The use of documentary research methods in social research. *African Sociological Review*, 10 (1), 221-230.

Morgan, D. L., & Morgan, R. K. (2001). Single – participant research design: Bringing science to managed care. *American Psychologist, 56,* 119 – 127.

Payne, J. (2004). *Key concepts in social research*. London: Sage Publications.

Poling, A., & Fuqua, R.W. (1986). *Research in applied behavior analysis*. New York: Planum Press.

Possi, M. K. (2000). Teaching social skills to preschool children with disabilities: Unpublished SIDA/SAREC funded research for the Faculty of Education. University of Dar es Salaam

Possi, M. A. K. (1994). Effects of money counting fluency training on the acquisition and generalization of money counting and purchasing skills by high school students with mental retardation. Ph. D. Thesis: Ohio State University: USA

Scott, J., (1990). *A matter of record, documentary sources in social research*. Cambridge: Polity Press

Shadish, W. R. Cook, T. D. & Campbell, D. T. (2002). *Experimental and quasi - experimental designs for generalized and causal inferences*. Boston: Houghton Mifflin.

Sidman, M. (1960). *Tactics of scientific research.* New York: Basic Books, Inc.

Skinner, B. F. (1953). *Science and human behaviour*. New York: Macmillan.

Tanskersley, M. Harjusola-Webb, & Landrum, T. (2008**).** Using single-subject research to establish the evidence base of special education. Accessed from http://www.baam.emich.edu/baamdownloads/baamstudyguides/singsub.pdf on 4 August, 2018https://doi.org/10.1177/1053451208321600 on 4th August, 2018

Tawney, J.W. & Gast, D.L. (1984*). Single subject research in special education*. Columbus: Charles E. Merrill Publishing Company.

Todd, T. J. (2001). Summary of basic single subject design types. Accessed from http://www.baam.emich.edu/baamdownloads/baamstudyguides/singsub.pdf on 4th August, 2018.

Weissberg, R. & Buker, S. (1990). *Writing up research.* New Jersey Englewood Cliffs, Prentice Hall Regents.

Williams, C. (2011). Research methods. *Journal of Business & Economics Research* (*JBER), 5*(3). https://doi.org/10.19030/jber.v5i3.2532

Woley, M. & Ezell, H. K. (1993). Subject descriptions and single subject research. *Journal of Learning Disabilities, 26*, 642 – 647.