Overview of Single-Subject Design in Special Education Studies

Ahmed Lowiheg Aldousari

Special Education Department, College of Education, Prince Sattam bin Abdulaziz University, A.aldousari@psau.edu.sa

Abstract

In recent years, there has been an increase in the use of single-subject design in special education research. This paper provides an insightful overview of the application of single-subject design within special education studies. The paper delves into an exploration of the fundamental concepts underlying single-subject design, its historical origins, and the wide range of purposes it serves. Furthermore, an examination of the strengths and weaknesses inherent to single-subject design is undertaken. Finally, an evaluation of withdrawal design, multiple baseline design, and alternating treatment design and their special education research application are offered. In this evaluation, the researcher specifically examines how these designs can be applied in special education research contexts. By exploring these variations, this paper provides insights into the diverse ways single-subject design can be applied to address the unique research needs and challenges in special education.

Keywords: Alternating Treatment Design, Multiple Baseline Design, Research Methodology in Special Education, Single-Subject Design, Withdrawal Design.

The single-subject design has emerged as an essential strategy applied in psychology, human behavior, and education (Richards, 2020). Besides, an evaluation of previous studies provides crucial background information concerning the concept to improve the implementation and application process. Over the years, studies have shown that single-subject designs offer an alternative framework to group methods and promote the achievement of study goals and objectives through evidence-based practice (Alnahdi, 2015; Horner et al., 2005; Maggin et al., 2018; Shadish & Rindskopf, 2007; Tankersley et al., 2008). The application of this research design in special education has gained prominence in recent years based on improving instructional goals and objectives. Notably, the special education approach's application focuses on a comprehensive evaluation of human behavior relative to independent variables through direct observation (Maggin et al., 2013; Kazdin, 2011; Wasson, 2009). Hersen (1990) reveals that the model evaluates human behavior over time rather than comparisons to other study groups. From this perspective, the single-subject design emphasizes the evaluation of human behavior changes based on external factors over time.

Previous studies point at numerous features are fundamental in the increased application in the education sector. For instance, the approach uses repeated and reliable measurements,

baseline treatment conditions, single variable rule, and the description of conditions (McMillan, 2004). Besides, Tankersley et al. (2008) agrees with the findings by suggesting that the repetition of interventions can improve the study outcomes, which is vital in achieving set goals and objectives. Furthermore, Kazdin (2011) reveals that applying a visual observation framework to determine changes in human behavior before and after implementing the interventions is pertinent to the approach. Thus, the application of single-subject research provides a well-articulated and established framework for identifying and determining the effectiveness of instructional models in special education. Moreover, previous studies have lauded the effectiveness of SSDs in evaluating students' behavior and developing policies and programs intended to improve their performance (Baker et al., 2018; Shadish & Rindskopf, 2007; Maggin et al., 2011). The application of such frameworks will continue to improve instructional models in education. However, studies point to an increased requirement to conduct more SSD research to determine the potential challenges and develop solutions to improve the process. Overall, the application of SSD in special education provides an effective mechanism for evaluating and improving student behaviors and performance.

Strengths and Weaknesses of the Single-subject Design (SSD)

Although considered useful in evaluating human behavior, the approach also exhibits numerous weaknesses that may affect the research outcomes. A well-detailed and comprehensive assessment of both strengths and weaknesses can improve the decision-making process and promote set goals and objectives. In this section, increased emphasis is placed on the evaluation of strengths and weaknesses by previous studies.

Strengths of SSDs

An increased application and implementation of the SSD framework in special education and other fields resonate with its effectiveness in achieving the goals and objectives. For instance, previous studies show that SSD provides a customized and individualized instructional model for children and people with disabilities (Alnahdi, 2015; Tankersley et al., 2008; Zhan & Ottenbacher, 2001). Thus, a practical application of this model and promote the achievement of study goals and objectives. Moreover, studies posit that this model's effectiveness resonates with the two significant elements, encompassing frequent measurement of behavior and repetitive application and evaluation of intervention strategies (Horner et al., 2005; Tankersley et al., 2008; Zhan & Ottenbacher, 2001). Although the approach's application is crucial in special education, increased emphasis on adherence to standards and guidelines is essential. Past studies evaluated the implications of SSD standards and found that such frameworks improve study outcomes, promote interventions, and improve the development and application of instructional models in special education (Maggin et al., 2013; Kratochwill et al., 2013). For that reason, the SSD frameworks exhibit advantages crucial to improvement in research and application of intervention models.

An increased emphasis on causal relationships between study variables is pivotal in SSDs. For instance, Maggin et al. (2018) suggest that implementing intervention strategies relative to the baseline is intended to determine such frameworks' implications on human behavior and performance. Similar studies indicate that since the subject serves as their control, other external variables' influence is minimized considerably (Alnahdi, 2015; Cakiroglu, 2012; Horner et al., 2005). The application of such frameworks in the study models improves the accuracy of study findings and promotes change management's applicability. In most cases, an increased emphasis on evidence-based practice is crucial for enhancing the study results' relevance. In that regard, Alnahdi (2015) affirms that SSDs exhibit a strong relationship with evidence-based

practices, provide a strong basis for developing functional associations between variables, and improve the researcher's ability to compare periodic changes in participant behavior. Furthermore, Cakiroglu (2012) highlight that SSDs allow researchers to measure the individual performance of participants, which is vital for achieving the set goals and objectives in special education. Indeed, the model's features improve its applicability in evaluating and implementing interventions in special education.

Weaknesses of SSDs

Although effective, the approaches encompass numerous weaknesses, which have been a subject of scholarly research over the years. A study by Shadish and Rindskopf (2007) has shown that SSDs exhibit myriad practical problems, which encompass their limitations to treatments without permanent effects and require fewer time durations to produce results. In most cases, such issues may exclude treatments and intervention frameworks that require long durations. Furthermore, researchers have questioned the application of this approach in cases requiring immediate interventions and results. For instance, this framework's application involves collecting comprehensive baseline data, which may be ineffective when the subjects need immediate help (Shadish & Rindskopf, 2007). In such scenarios, other models should be incorporated to improve the efficiency of interventions. Although effective in improving the accuracy of study results, numerous problems associated with repetitive data collection exist. In most cases, researchers need to focus on further investigations to analyze and improve the outcomes, which might be tiresome, and time-consuming (Zhan & Ottenbacher, 2001). Furthermore, the approach exhibits higher concern rates regarding external validity than traditional models (Alnahdi, 2015). To minimize these threats, Horner et al. (2005) recommend frequent testing experimental effects through a variation of settings and participants. Therefore, addressing such challenges and weaknesses can improve research outcomes and promote set goals and objectives.

Nonetheless, critics of this framework have questioned its generalizability on a larger population. Besides, research shows that limitations exist in SSD study results' generalizability, primarily based on the increased focus on single subjects (Alnahdi, 2015; Zhan & Ottenbacher, 2001). Understandably, responses to intervention and treatments may vary from person to person. However, study results can be replicated on other subjects to determine their viability and make changes intended to address target groups' specific needs (Zhan & Ottenbacher, 2001). Significantly, diversities in human behaviors, expectations, and environments may contribute to difficulties in applying models on a larger population (Alnahdi, 2015). Therefore, the application of the SSD models is viable when dealing with intervention strategies targeting the study subjects. Another problem associated with results' generalizability emanates from the visual analysis, which contributes to numerous inconsistencies (Zhan & Ottenbacher, 2001). Despite the strengths, addressing the outlined weaknesses is needed to improve the study results and promote effective special education interventions.

Single-subject Design: Example Design Choices

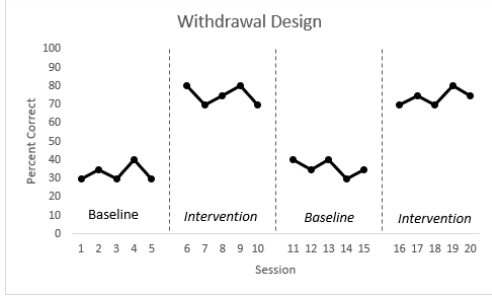
Over the years, scholars and clinical researchers have developed numerous SSDs, which can be applied based on nature, type, and type of information required. In this section, an evaluation of withdrawal design, multiple baseline design, and alternating treatment design and their special education research application. Although different, the SSD methodology provides a framework for evaluating human behavior, psychology, and relationships between variables.

Withdrawal Design

The application and implementation of withdrawal design in SSDs are important in special education instruction. The model

incorporates numerous frameworks intended to determine the relationship between the independent and dependent variables (Maggin et al., 2018; Cakiroglu, 2012). Besides, treatment or intervention practices are considered the independent variables, while behavior change, or performance is the dependent variable. Previous studies suggest that determining the relationship between the two variables, especially the special education intervention on student behaviors and performance, is pertinent to the model (Cakiroglu, 2012; Tankersley et al., 2008; Horner et al., 2005). For instance, the approach incorporates the aspect of withdrawal at specific points in the process. In most cases, changes are recorded during the interventions' implementation and after the strategies' withdrawal on numerous occasions (Alnahdi, 2015; Maggin et al., 2018). For instance, SSD standards advise that withdrawal designs, which are also called reversal designs, should incorporate more than three data points or phases (Kratochwill et al., 2013). However, the approach exhibits numerous limitations that interfere with its applicability in measuring interventions. Understandably, the model cannot be applied when dealing with dangerous and critical behaviors, making it unethical (Richards, 2020). For instance, implementing such an approach to drug use problems and other addiction types may contribute to the participants' health problems. Despite the limitations, the intervention strategies' implementation can help determine their implication on reading ability for children with learning disabilities.

Notably, the strategy must incorporate baseline conditions, which resonate with student reading abilities without the intervention. The baseline phase is regarded as an A while introducing the framework resonates with point B, contributing to an AB-ABA-ABAB intervention framework (Richards, 2020). Throughout the introduction and removal of the treatment during the study, the model allows for trustworthy assessment of the efficacy of an intervention (Alnahdi, 2015). For that reason, implementing the strategy for elementary school children with reading difficulties requires the implementation of the interventions, observing the changes, and comparing the transformation with the baseline. Researchers can associate the positive correlation between the independent and independent variables in the research, which is essential to improving the study outcomes and special education instruction. The chart below illustrates the implementation of withdrawal design. (All information is hypothetical)

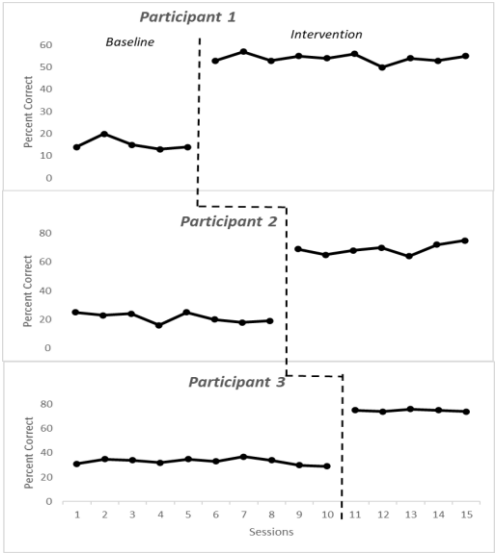


Multiple Baseline Designs

Educators and researchers can apply the multiple baseline design to promoting reading abilities for elementary school children with reading disabilities. Unlike in withdrawal design, the model emphasizes numerous behaviors, settings, and subjects, eliminating the need to withdraw interventions (Carr, 2005; Cakiroglu, 2012; Maggin et al., 2018). In that regard, this choice evaluates the relationship between independent and dependent variables by comparing multiple behaviors, settings, or subjects (Maggin et al., 2018; Richards, 2020). From this perspective, interventions are introduced in one setting, behavior, or subject while the others are considered the baseline. Interestingly, past studies affirm that the strategy can be implemented when the interventions are irreversible, permanent, and non-withdrawable (Cakiroglu, 2012; Zhan & Ottenbacher, 2001). Based on such aspects, the multiple baseline design would be more reliable than the

withdrawal design when administering permanent changes and promoting long-term goals and objectives. Thus, the model would be viable and effective in implementing intervention strategies for elementary children with reading difficulties.

Implementing reading intervention strategies through this framework can improve the study results and promote instructional goals and objectives. Studies have also provided three major frameworks for implementing the multiple baseline design that focuses on behaviors, settings, and subjects (Richards, 2020; Tankersley et al., 2008; Zhan & Ottenbacher, 2001). In the first framework, multiple behaviors by the same individuals are evaluated. One of the actions is considered the baseline to the study and provides a comparative standard in assessing interventions' impacts. In this case, researchers can introduce interventions on the reading behavior of the elementary student's reading abilities, which are then compared to a chosen baseline skill. Second, emphasis on settings illustrates that individuals are evaluated across multiple situations and environments (Tankersley et al., 2008; Zhan & Ottenbacher, 2001). For instance, researchers should determine a student's reading ability in different situations, especially in class, family, and social settings. Interventions are introduced in one setting and compared to the other baseline settings, helping determine the relationship between the variables. Third, the subject's framework considers multiple individuals' behaviors during the study (Richards, 2020). For example, reading intervention strategies can be implemented on one student and compared to another student in the baseline phase. The chart below illustrates the implementation of the multiple baseline design across participants. (All information is hypothetical)

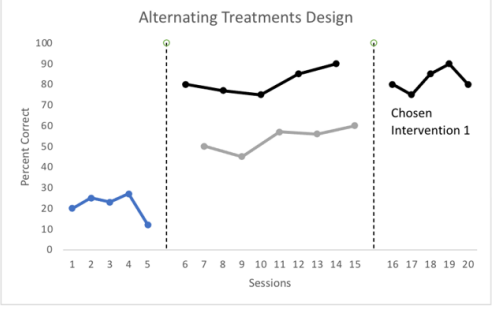


Alternating Treatments Design

Researchers implement alternating treatment design to determine the effectiveness of numerous intervention strategies or treatments. Notably, the studies affirm that the approach compares multiple treatment frameworks and their implications on the same behavior and helps determine the most effective method (Richards, 2020). Understandably, numerous interventions tend to have diverse implications for human behavior. In that regard, the model alternates different interventions randomly and rapidly and evaluates their effects on the behavior (Zhan & Ottenbacher, 2001). Unlike withdrawal and multiple baseline designs, some research design models do not apply a baseline as interventions or treatments are introduced rapidly to the subjects across sessions, times, and days (Cakiroglu, 2012; Zhan & Ottenbacher, 2001). From this perspective, pre-intervention data, which is needed for comparison, is not collected. In other categories of this model, a baseline may follow several alternative treatments and– in some cases – final interventions (Kratochwill et al., 2013). The baseline provides a point of comparison for the

alternative treatments, while the final intervention resonates with the most effective strategy for achieving the intended outcomes (Richards, 2020). For this model, researchers evaluate numerous intervention frameworks and choose the most effective one. Therefore, improving elementary school children's reading abilities can incorporate multiple interventions, which are concurrently assessed, and the most effective one chosen to improve instructional goals and objectives. The chart below illustrates the implementation of the alternating treatments design.

(All information is hypothetical)



The SSD implementation has taken a central role in human behavior and clinical research in recent years. Besides, numerous articles have incorporated the SSD to measure the effectiveness of intervention and treatment frameworks. In this section, the paper evaluates and examines how past studies have employed the research design to achieve the set goals and objectives, especially in reading interventions. For instance, a study by Hofstadter-Duke and Daly (2011) investigated the implications of an experimentally derived and peer-mediated strategy in reading intervention on a seven-year-old Caucasian girl with reading problems. The study evaluated her oral reading fluency by experimenting with her reading speed and accuracy, which provided a framework for developing and suitable intervention. The research also applied a generalization probe to determine the peer-mediated reading intervention's effectiveness in improving her oral reading fluency. Through this strategy, the researchers examined changes in her reading abilities compared to the baseline after every session. Furthermore, another study by Josephs and Jolivette (2016) evaluates the effects of peer-mediated instruction, repeated reading, and continuous reading to improve language fluency among students. The researchers applied alternating treatments design to determine the most effective strategy on improving the oral reading fluency. The researchers also conducted Pre-and post-assessment to determine student reading abilities changes, which helped assess the intervention strategies. Therefore, generalization probes, alternating treatments design and continuous assessment are essential in the studies.

Moreover, numerous other studies have emphasized applying different strategies to evaluate the intervention strategies' effects on comprehension and reading fluency. For instance, studies by Barber et al. (2018) and Council et al. (2016) examined whether computer-based interventions and programs improved reading fluency and comprehension among urban first graders and primary-aged black girls, respectively. For both studies, the authors administered generalization probes and pre- and post-assessments to determine the intervention models (Council et al., 2016; Barber et al., 2018). Through such strategies can evaluate the effectiveness of the interventions by assessing changes in reading and comprehension fluency. Moreover, a study by Tam et al. (2016) applies multiple baselines across several students to examine the implications of intervention programs on learners with reading problems. Similarly, Eckert et al. (2000) assess the SSD model's application to demonstrate school-based reading interventions' effectiveness. Both studies focus on the implications of reading interventions on student fluency. In evaluating intervention procedures' effectiveness, the first study applied pre- and post-assessment frameworks and generality probes (Tam et al.,

2016). In contrast, the second study focused adapted alternating treatment design to determine the interventions' viability (Eckert et al., 2000). Overall, the mentioned strategies are common in SSD research.

Discussion

Single-subject design (SSD) has become a crucial research methodology in the field of special education. It offers a flexible and robust framework for investigating the effectiveness of interventions for individuals with disabilities, allowing researchers to examine changes in behavior through repeated measurement over time. This approach stands in contrast to traditional group designs, which rely on comparisons between groups of participants. SSD is particularly advantageous in special education because it allows for intensive study of individual participants, often yielding insights that can be directly applied to educational practice (Horner et al., 2005).

The key strength of SSD lies in its capacity for customization and individualized evaluation, making it well-suited for populations with diverse needs, such as students with learning disabilities. The focus on frequent measurements and ongoing intervention adjustment ensures that educators can track the impact of instructional methods in real-time, providing opportunities for immediate modifications (Kazdin, 2011). Furthermore, SSD's reliance on visual analysis, rather than statistical significance, allows for clearer interpretation of intervention effects on a participant's behavior, a feature that is critical in special education where behavioral changes may be subtle but meaningful (Maggin et al., 2018).

Despite its strengths, SSD has some limitations. One of the primary weaknesses is its generalizability. Since SSD focuses on individual participants, it can be difficult to extend the findings to larger populations. Additionally, SSD often requires significant time and resources, particularly in the data collection process, which can be demanding for educators and researchers (Shadish & Rindskopf, 2007). Furthermore, ethical concerns may arise in using withdrawal designs where the removal of an effective intervention could harm the participant, particularly in sensitive educational contexts (Richards, 2020).

In conclusion, SSD plays a vital role in special education research, offering a methodologically sound approach to evaluating interventions. While its limitations must be considered, particularly in terms of generalizability and ethical concerns, its strengths make it a valuable tool for improving educational outcomes for students with special needs. Continued research using SSD can contribute to refining and expanding its application in various educational contexts.

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