EDUCATION IN HEALTH SCIENCES

Adaptive single case design (ASCD): a model for education, training, and assessment

Estudo de caso único adaptado (ASCD): um modelo para educação, treinamento e avaliação

Jimmie Leppink[1]
orcid.org/0000-0002-8713-1374
j.leppink@gmail.com

Abstract

Aims: single case designs (SCDs) can help us understand change in learning-related variables, such as knowledge and skill, at the level of an individual learner, at the level of a team or group of learners, or at the level of a situation or system. Adaptive single case design (ASCD) is a new model that integrates (i.) elements of methods of education, training, and assessment that, through research methods other than SCDs, have received solid empirical evidence in the research literature and (ii.) principles of SCDs that can facilitate the integration of research in everyday practice. The rationale behind ASCD is to allow rapid evidence-based decision making in the practice of education, training, and assessment, at the unit of analysis – individual, group, team, situation, or system – that is considered appropriate in the context at hand.

Method: an ASCD algorithm is introduced and discussed in the context of change at the level of the individual, change in a group or team, and change in a situation or system.

Results: ASCD can be used to understand change at each of the previously mentioned units of analysis at any number of units including a single unit (one individual, one team, or one situation or system), and this change can be used for research purposes as well.

Conclusion: ASCD enables both evidence-based practical decision making and research without stringent demands on the number of learners, groups, teams, situations, or systems.

Keywords: single case design, adaptive single case design, aprendizado, inovação pedagógica.

Resumo

Objetivos: estudos de caso único podem nos ajudar a entender a mudança nas variáveis relacionadas ao aprendizado, como conhecimento e habilidade, no nível de um aluno individual, no nível de uma equipe ou grupo de alunos, ou no nível de uma situação ou sistema. O Estudo adaptativo de caso único (ASCD) é um novo modelo que integra (i.) elementos de métodos de educação, treinamento e avaliação que, por meio de métodos de pesquisa que não sejam estudos de caso único, receberam evidências empíricas sólidas na literatura de pesquisa e (ii.) princípios de estudos de caso único, que podem facilitar a integração da pesquisa na prática cotidiana. A lógica por trás do ASCD é permitir a rápida tomada de decisão baseada em evidências na prática da educação, treinamento e avaliação, na unidade de análise – individual, grupo, equipe, situação ou sistema – que é considerada apropriada no contexto em questão.

Método: um algoritmo ASCD é introduzido e discutido no contexto de mudança no nível do indivíduo, mudança em um grupo ou equipe e mudança em uma situação ou sistema.

Resultados: o ASCD pode ser usado para entender a mudança em cada uma das unidades de análise mencionadas anteriormente em qualquer número de

1   Hospital Virtual Valdecilla (HvV), Santander, Cantabria, Spain.

unidades, incluindo uma única unidade (um indivíduo, uma equipe ou uma situação ou sistema), e para fins de pesquisa.

Conclusão: o ASCD permite a a pesquisa e a tomada de decisão prática baseada em evidências, sem demandas rigorosas sobre o número de alunos, grupos, equipes, situações ou sistemas.

Palavras-chave: estudo de caso, estudo adaptativo de caso único, aprendizado, inovação pedagógica.

Introduction

Health professions education (HPE) is about preparing current and future professionals for practice in dynamic and ever-evolving environments, using methods that are supported by evidence and do not contribute more than is necessary to already enormous pressures on our healthcare systems. This requires theory--and-practice-driven research on the impact of existing and new methods for education, training, and assessment on professional practice (1), using research designs that consist of series of measurements of outcomes of interest from the same individuals, possibly before, during, and after education or training events. A type of research design that can do that is known as Single Case Design (SCD) (2). A hypothetical SCD example is presented in **Figure 1**.
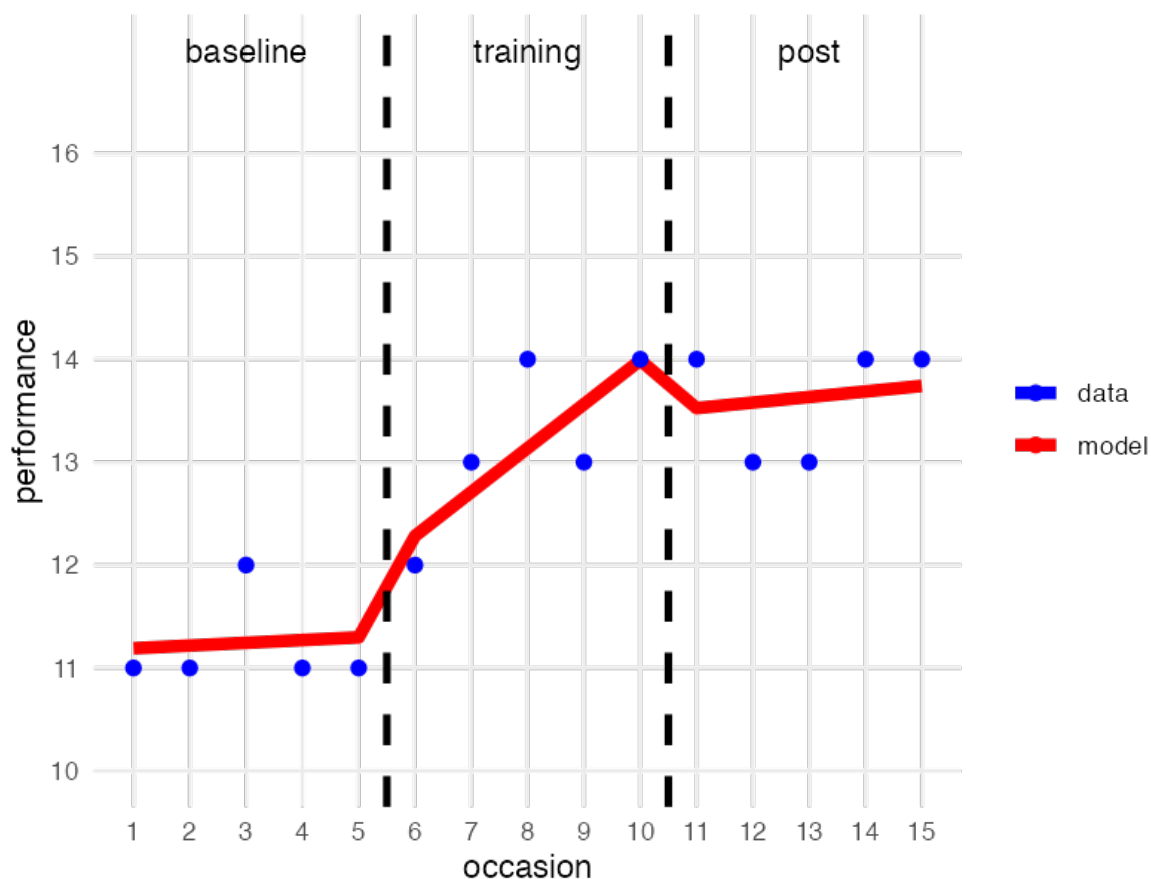

Figure 1. Example of a pre-during-post design: five measurements in each of baseline (pre), training (during), and after training (post), with higher scores (blue dots) indicating better performance, and the best fitting moving average model (red line).

Figure 1 demonstrates a trajectory of the performance of Student X in a range of patient en counters measured on a standardized integer scale ranging from 0 (min) to 20 (max), with 11-12

indicating borderline performance (i.e., performance almost at the expected level, with minor lapses that have no serious implications for patient outcomes), 13-14 indicating satisfactory performance, and 15+ indicating performance above the expected level. There is one encounter per week, with the total number of weeks being 15. The figure demonstrates borderline performance prior to the training (baseline, weeks 1-5), then an increase in performance in the five-week training period (weeks 6-10), followed by continued satisfactory performance after the training (weeks 11-15). The red line indicates the best fitting model which can be used for statistical testing as outlined for example in an article published in this journal in the 2021 edition (3), using the *nlme* package (4) in Open-Source program *R* version 4.0.5 or later (5). This SCD can help practitioners and researchers to understand to what extent this student's performance has improved during and after compared to before the training, and where data from several students are available, they can be combined to draw conclusions at the level of a group (3).

Although in the case of Student X the phase-to-phase transitions are fixed at 5-week intervals,

adaptive or *sequential* testing designs enable us to shorten or lengthen specific phases as a function of change or lack of change (6). For example, three or more below-satisfactory (i.e., borderline, or worse) performances in the baseline phase might be a criterion for having to take the training in the first place (e.g., consistent satisfactory performance in the baseline phase meaning no need to take the training), and for students taking the training decision rules could include – for instance – at least 3 satisfactory performances during and at least 3 satisfactory performances after training. This form of *adaptive* SCD (ASCD) can help to direct resources for education, training, and assessment to where they are needed, and to avoid or minimize overuse of those resources where they are *not* needed.

An algorithm for everyday research and practice

Although the practice of education, training, and assessment can vary across settings and contexts, **Table 1** presents an 8-step ASCD algorithm that can be applied regardless of the setting or context.

TABLE 1 – The adaptive single case design (ASCD) algorithm: 8 steps to rapid evidence-based decision making for everyday practice and research

Step	What
i.	Formulate requirements
ii.	Create a readiness plan
iii.	Establish assessment criteria
iv.	Develop learning tasks
v.	Outline a measurement plan
vi.	Plan feedback
vii.	Collect data
viii.	Evaluate

The first thing we need to do is formulate *requirements* (step 1) and key performance indicators to measure those requirements, such as a growth in knowledge or skill, better relations between people at work, or an improved patient experience (7). Once we have these requirements

and indicators clear, it is time to talk to relevant stakeholders (e.g., practitioners, teachers, deans, patients) and jointly create a *readiness plan* (step 2) which outlines key knowledge and skills needed, key tasks and situations which require the application of those key skills and knowledge, and

activities that facilitate continuous practice and development. These first two steps will help us establish *assessment criteria* (step 3) and *learning tasks* (step 4) that help the learner to develop knowledge and skills, to practice situations, and to acquire a better understanding of what are good indicators of good and not so good performance.

In complex domains like in HPE, it is important to take a longitudinal approach to learning and assessment, which allows us to gradually increase the level of challenge for the individual learner with the increase of that learner's proficiency (8-10), and outline a *measurement plan* (step 5) and *feedback plan* (step 6) that enables stakeholders to monitor the learner's progress and to discuss strengths and weaknesses that can help the learner to continue growing (11-14). With steps 1-6 in place, it is time to *collect data* (step 7) and, apart from giving feedback to the learner, *evaluate* (step 8) how different learning tasks and other events have contributed to the learner's development (15). The latter may have important implications for steps 1-7 in future editions (e.g., adapting learning tasks or a change in the measurement or feedback plan).

ASCD can be applied to the individual learner, teams of learners, or situations and systems, as discussed in the next section.

Understanding change at different levels

SCDs can provide parametric and nonparametric statistics to understand change at the level of the *individual learner* (2, 3, 15), and where more than one outcome variable is measured simultaneously (e.g., knowledge and skills), the temporal order of change in these different variables (16). This is important because while educational research traditionally has largely focused on questions regarding the progress of groups of learners (e.g., does Method A result in more progress than Method B?) much of educational practice revolves around the questions how an *individual* learner is progressing and whether a given individual is ready to enter practice. ASCD uses this potential of SCDs and allows for flexibility (e.g., an earlier or later start of a new phase) as a function of the individual learner's progress. Decision rules for moving from one phase to the next or for deciding on readiness to practice can be based on simple numeric indicators (e.g., X number or X percent of correct performance) or on statistical testing criteria such as a confidence interval (6).

Understanding change and temporal order of change can also be important at the level of team dynamics. For example, in a team of four authors, ASCD can help to understand individual contributions to a manuscript at different points in time (e.g., number of words per week in a 10-week essay assignment) and whether there are tendencies across the weeks (e.g., Author A contributing first, followed by Authors B and C, and occasionally Author D as a few words to complete the cycle or week). Where individual contributions are very small or absent, steps 4-6 in ASCD can help to intervene (notably steps 4-6) and check progress after intervention (steps 7-8). In a hospital setting, ASCD can help to monitor the performance of students or residents in a larger team, and how the relations with other team members develop (17), which may be followed by an intervention of some kind where performance or relations do not meet the standards (as outlined in steps 1-3). Just like in team sports poor performance needs to be followed up by specific training activities with measurement and feedback (steps 4-6), in academic and healthcare settings below-satisfactory performance needs to be reduced through practice, coaching, and debriefing (12, 13). A solid longitudinal measurement plan (step 5) can help to study the behavior of teams and their individuals in a variety of situations (e.g., different types of patients in a healthcare setting), and feedback – for example through coaching and debriefing – can serve as timely interventions to facilitate change and/or progress to a next phase. Simultaneously, specific situations in themselves can also serve as events that hinder or facilitate change, and ASCD can – through the features of SCDs (15) – also help to understand the exact or approximate impact of these events.

Finally, in a broader picture, teams are part

of larger systems. For example, in a healthcare setting, teams of professionals and residents (or in some countries students) communicate with patients and their caregivers (e.g., family members, friends). Although many patients do not return to the healthcare setting repeatedly or regularly, ASCD can help to monitor the performance of professionals, residents, and healthcare teams in terms of patient outcomes and in terms of the experience of patients and caregivers, and to design specific interventions (e.g., learning or practice tasks, team building activities) where that is considered necessary or helpful.

Discussion

Educational research has traditionally largely focused on relations between variables and changes in larger groups. This kind of research will continue to be important in the future, not in the last place to do research on (i.) the reliability and validity of existing and new measurement instruments and (ii.) the effectiveness of different learning, teaching, and assessment methods under different conditions (e.g., learners with different levels of experience or proficiency). Simultaneously, key questions in educational practice revolve around the performance and progress of individuals and small teams who often operate in very specific settings or situations and are part of local systems. ASCD provides an approach to study these questions by integrating research in everyday practice. The aim of ASCD is not to replace but to *complement* traditional (and still dominant) larger-group research in education, by providing researchers and practitioners with a model that can facilitate evidence-based decision making where numbers of individuals or teams (or systems) are small and perhaps even as small as 1. Researchers and practitioners should be encouraged to share findings of both kinds of research, because they respond to partially different kinds of questions and at the same time even $N = 1$ findings can be useful in meta-analyses on questions that have traditionally been addressed by larger-group studies.

Notes

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Availability of data and responsibility for the results
The author declares to have had full access to the available data and they assume full responsibility for the integrity of these results.

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Jimmie Leppink

PhD in Statistics Education, LLM in Forensics, Criminology and Law, and MSc in Psychology and Law from Maastricht University, the Netherlands; MSc in Statistics from Catholic University of Leuven, Belgium; currently Research Director at Hospital Virtual Valdecilla (HvV), in Santander, Spain.

Mailing address

Jimmie Leppink

Hospital virtual Valdecilla

Santander, Spain; 39008

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