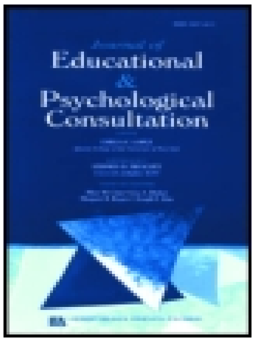

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Cost-effectiveness of Consultation for a Daily Report Card Intervention: Comparing In-Person and Online Implementation Strategies

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ABSTRACT

Teachers can implement a high quality Daily Report Card (DRC) intervention when they receive face-to-face consultation or interactive online supports. Yet, it is unclear which method is most cost-effective. Using an ingredients-based approach and societal perspective, we examined costs and cost-effectiveness (compared to typical practice) of three implementation strategies (face-to-face standard consultation, face-to-face enhanced consultation, interactive online supports) with 112 elementary school teachers. Teachers received consultation for DRC implementation with one student with or at risk for ADHD. Over 2 months, we collected data on teachers' implementation and changes in student behaviors. Regarding cost per student, enhanced consultation was the most costly ($864), followed by standard consultation ($634) and interactive online supports ($307). Regarding cost-effectiveness (costs required to achieve the desired effect beyond typical practice), interactive online supports were the most cost-effective followed by enhanced consultation and standard consultation. We discuss implications for research and maximizing outcomes given dollars spent.

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In the context of multi-tiered systems of support, elementary school teachers are increasingly being expected to implement both universal classroom management strategies to prevent disruptive behavior and targeted interventions with students who need additional support. However, there is wide variability in teachers' implementation of these interventions (e.g., Fabiano et al., 2010; Owens et al., 2017). Multiple implementation strategies have been used to facilitate teachers' use of effective intervention strategies, including one-time workshops (Jurbergs, Palcic, & Kelley, 2010), behavioral problem-solving consultation which represents a best practice in school psychology (Kratochwill, Altschaefl, & Bice-Urbach, 2014), behavioral problem-solving consultation with enhancements (e.g., with motivational interviewing; Owens et al., 2017; Reinke, Lewis-Palmer, & Merrell, 2008), and

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interactive on-line technologies (Mixon, Owens, Hustus, Serrano, & Holdaway, 2019; Owens et al., 2019). Although studies that compare the efficacy of multiple implementation strategies are emerging (e.g., Bradshaw, Pas, Goldweber, Rosenberg, & Leaf, 2012; Owens et al., 2017), we are unaware of any studies that have estimated the cost-effectiveness of multiple approaches.

Cost-effectiveness analyses represent a critical factor that could inform resource allocation in schools. For example, school administrators often have to choose implementation support activities (e.g., one-time workshops; ongoing consultation) from among options that likely vary in cost, intensity, and effectiveness. To be able to reduce unnecessary costs (e.g., associated with applying a more intensive approach than needed) and maximize the effects of costly resources by only applying intensive supports to teachers who need it, we need to understand the costs and cost-effectiveness of multiple strategies. This study advances the literature by comparing the costs of three implementation strategies among all consented teachers (intent-to-treat analyses) and among the subset of teachers who were actively engaged (completers analyses), and by examining the cost-effectiveness of multiple implementation strategies relative to the typical practice.

Implementation strategies for classroom interventions

Implementation strategies are defined as strategies, methods, or techniques used to facilitate the adoption, use, and sustainment of an evidence-based practice (Cook, Lyon, Locke, Waltz, & Powell, 2019; Proctor, Powell, & McMillen, 2013). In the field of school psychology, these are also referred to as implementation supports. There is a large body of literature that shows that behavioral problem-solving consultation is an effective implementation strategy. Some studies have examined the impact of such face-to-face consultation (relative to typical practice) when offered to teachers on a biweekly or monthly basis over 1 year, with (Murray, Rabiner, Schulte, & Newitt, 2008) or without parents present (Fabiano et al., 2010; Owens, Murphy, Richerson, Girio, & Himawan, 2008) and with (Owens et al., 2017) or without observation and performance feedback (Fabiano et al., 2010).

These studies document that these applications of problem-solving consultation as an implementation strategy produce adequate implementation outcomes and subsequent positive student outcomes (Frank & Kratochwill, 2014; Noell & Gansle, 2014; Solomon, Klein, & Politylo, 2012). Namely, they are effective in producing significant improvement in teachers' use of classroom management strategies (e.g., Conroy et al., 2015) and effective in helping teachers achieve high implementation integrity with a targeted intervention (e.g., across studies, on average teachers implemented a daily report card intervention on 70% to 80% of school days; Fabiano et al., 2010; Owens et al., 2008). Further, problem-solving consultation is acceptable to teachers (Conroy et al., 2015). Notably, these applications also subsequently improve student outcomes; producing moderate to large changes in student behavior relative to baseline among students receiving the intervention (Conroy et al., 2015; Owens et al., 2012). However, there is significant variability in teacher implementation integrity within each approach. For example, in the context of ongoing face-to-face problem-solving consultation, some teachers implemented a targeted intervention on 10% of eligible days, whereas others implemented the intervention on 100% of eligible days (Fabiano et al., 2010; Owens et al., 2008).

Researchers have yet to quantify the costs of these various implementation strategies, or their relative cost-effectiveness in producing desired outcomes. Given the documented variability across teachers using the same level of supports, researchers also need to consider variability in costs within programs. Namely, variability in implementation is likely to result in inefficiencies of dollars spent on the approach, as not all teachers adopt or benefit from each approach. This variability may also produce financial inefficiencies as it relates to student outcomes. That is, although costs of the intervention may be spread across several students, it may be that only a few students are experiencing beneficial effects. Thus, more information is needed regarding how variability in implementation impacts per student costs associated with the approach.

Innovations in implementation strategies

Given the documented variability in teachers' implementation of classroom interventions (Fabiano et al., 2010; Owens et al., 2008) as well as the common barriers to implementation as reported by teachers (Collier-Meek, Sanetti, & Boyle, 2019; Long et al., 2016), researchers have recently been examining innovative adaptations to problem-solving consultation to enhance implementation outcomes (i.e., adoption and implementation). Some adaptations have focused on enhancing individualization by including techniques associated with motivational interviewing and/or cognitive behavioral therapy (Collier-Meek, Sanetti, Levin, Kratochwill, & Boyle, 2019; Owens et al., 2017; Reinke et al., 2008) and by targeting mechanisms purported to affect implementation outcomes (e.g., knowledge, motivation, self-efficacy, planning). Although it is possible that this individualization may prove to be more costly, the results from these trials suggest that these enhanced approaches are acceptable to teachers and may also be more effective for some teachers and their students than others. Other adaptations are leveraging interactive online technologies to target specific barriers to adoption and implementation (e.g., time demands; intervention compatibility). Pilot studies of the use of interactive online technologies reveal that this strategy is acceptable to a subset of teacher, as 30-50% can adopt and implement a classroom intervention with high quality with very minimal face-to-face supports, and can produce moderate to large change in student behaviors (Mixon et al., 2019; Owens et al., 2019). These results suggest that there may be some cost-efficiencies with the use of technology, as it may be more feasible to provide to a larger number of teachers. Although it is frequently assumed that leveraging technology is a cost-effective approach, a systematic review revealed mixed evidence for the cost-effectiveness of technology-based health-care programs (de la Torre-díez, López-Coronado, Vaca, Aguado, & de Castro, 2015). This suggests that additional research is needed to investigate the assumption that technology is cost-effective within the teacher consultation literature.

The need for cost-analysis and cost-effectiveness studies

The previously reviewed literature reveals the complex challenges that school administrators face in attempting to maximize the impact of their professional development funds. One line of research that could facilitate data to effectively inform administrators' decisions is that of economic evaluations. Cost-analysis research involves estimating the total costs of an intervention based on the total and component resources required to implement the intervention, or an ingredients-based approach (Belfield & Levin, 2013). We are unaware of any study that has described the relative costs of different implementation strategies. Thus, it may be difficult for administrators to know if approaches that have been categorized as best practices are a value within their professional development budget. When examining costs associated with different implementation strategies, it is important to account for variability in rates of implementation, as strategies that lead to minimal engagement may result in greater costs per student receiving the intervention. Thus, the total cost of the program should be considered both as costs distributed across the full sample (intent-to-treat approach) as well as distributed across the participating subsample (completers approach).

Cost-effectiveness analyses (CEA) compare the costs of two strategies to produce a single beneficial outcome (Crowley et al., 2018). Thus, CEA provide a ratio of the cost of a strategy per unit of effect (i.e., incremental cost-effectiveness ratio; ICER) relative to conditions as usual, and this approach can answer the question of which strategy requires more funds for the same effect. We are unaware of any studies that examine cost-effectiveness across different implementation strategies targeting teacher's implementation of classroom interventions. Claims are often made that technology can lead to efficiencies that are cost-effective; however, to our knowledge, this has not been tested in the context of consultation research. By understanding the relative costs and cost-effectiveness of different implementation strategies, administrators may be able to maximize teacher and student outcomes in relation to dollars spent.

Current study

Using an ingredients-based approach (Belfield & Levin, 2013) within a societal perspective (i.e., net costs to society), we sought to conduct and economic evaluation of three implementation strategies that vary in focus and intensity (i.e., face-to-face standard consultation, face-to-face enhanced consultation, or interactive online supports), each of which were designed to promote teachers' adoption and implementation of a daily report card (DRC) intervention. The standard condition represented best practice procedures in behavioral problem-solving consultation (Frank & Kratochwill, 2014); consultants refrained from using active ingredients of the enhanced condition. The enhanced condition adopted a behavioral problem-solving approach but included individualized techniques grounded in motivational interviewing and cognitive behavioral therapy to enhance teacher knowledge of behavioral principles and interventions; motivation, self-efficacy, and beliefs related to intervention adoption and implementation, and skills in classroom management. In the on-line condition, teachers were given a website that included brief video tutorials and an interactive "wizard" that was designed to mirror face-to-face consultation, guiding teachers in selecting target behaviors, tracking baseline data, setting goals, and modifying the goals to shape student behavior over time. See Table 1 for a visual display of the activities completed in each condition.

We selected the DRC intervention because it (a) builds upon effective universal classroom management strategies, (b) is effective in changing a variety of behaviors (e.g., on-task, work productivity, following instructions, remaining in seat/area, respect), including those associated with attention-deficit hyperactivity disorder (ADHD) and oppositional and conduct problems (Pyle & Fabiano, 2017; Vannest, Davis, Davis, Mason, & Burke, 2010), (c) is acceptable to teachers (Girio & Owens, 2009), and (d) can produce moderate to large effects within 2 months of implementation (Owens et al., 2012; Pyle & Fabiano, 2017).

To achieve Aim 1 we conducted a cost-analysis using all consented teachers (intent-to-treat). To examine how variability in teacher implementation affects intervention costs, we also estimated the costs of each approach using only the subset of teachers who actively engaged in the approach (completers; Aim 2). Lastly, we estimated the ICERs, or ratio of cost per effect, to examine the cost-effectiveness of each implementation strategy relative to the cost of typical practice (Aim 3). Sensitivity analyses were conducted to account for uncertainty present in cost estimates and enhance the robustness of our estimates.

Table 1. Activities completed in each implementation strategy condition.

	Standard Consultation	Enhanced Consultation	On-Line
Initial Teacher Workshop	X	X	X
Classroom Management Interview	X	X (+ MI Values Interview)	
Target Behavior Selection	X	X	DRC Wizard
Baseline Data Tracking	X	X	DRC Wizard
DRC Development Meeting	X	X	DRC Wizard
DRC Launch Meeting (parents invited)	X	X	Scripts & Procedures available on-line
Target Behavior Data Tracking	X	X	On-Line
Weekly Integrity Observations	X	X	
Biweekly Consultation	X	X	
Review of Student Graphs	X	X	Graphs on-line
Performance Feedback	Brief	Enhanced	
MI-Informed Strategies		X	
Cognitive Behavioral Strategies		X	
Knowledge Component		X	
Beliefs Component		X	
Skills Component		X	

MI = motivational interviewing. Knowledge Component involved *News You Can Use* fact sheets; Beliefs Component involved identification and modification of teacher values and beliefs, assessment and focus on motivation and self-efficacy; Skills Component involved role plays and skills practice. Brief = limited to 5 to 10 minutes and unless the teacher initiated discussion of other content, the discussion and problem solving remained child-focused; Enhanced = comprehensive review of child and teacher behaviors from the observations, highlighting connections between teacher integrity behaviors and child outcomes; highlight discrepancies between teacher beliefs and behavior to facilitate either skills practice or a discussion of related beliefs.

Method

Participants

Data for the analyses were drawn from two studies (Owens et al., 2017, 2019). Participants in the first study were 58 teachers (each with one target student who received a DRC intervention) who were recruited in the fall of 2014 from eight participating schools across two sites in the United States (28 from Ohio and 30 from Florida) and randomly assigned to either the standard or enhanced consultation condition. Participants in the second study were 54 teachers (each with one target student who received a DRC intervention) who were recruited in the fall of 2017 from 10 elementary schools across two school districts in Alberta, Canada and participated in the on-line condition.

Across both studies, participants reported an average of 13.2 years of teaching experience (*SD* = 8.1); there were no differences in teaching experience reported by teachers in the two samples. In both studies, most teachers were women (Study 1: 93.1%; Study 2: 75.9%) who taught in general education classes (Study 1: 100%; Study 2: 85.2%). In Study 1, teachers were more likely to be teaching K-2 (Study 1: 51.8%; Study 2: 40.7%) and more likely to have reported having a Master's degree (Study 1: 62.1%; Study 2: 18.5%).

In Study 1, most target students were male (76%). Approximately half of the sample (54%) identified as Hispanic. Most students were from low to middle socioeconomic backgrounds (17.2% had a household income under 15,000, USD 55.2% had an income between 15,000 and 49,999, USD 18.9% were above 50,000, USD 8.6% did not report income). Because the focus of Study 2, which examined the interactive online supports, was on teacher implementation behaviors, demographic information about target students was not obtained.

With regard to school level data, in Study 1, the schools were diverse. The five Ohio schools had an average of 377 students per school, with 12%-29% of students receiving special education services and 35–75% receiving free or reduced lunch services. The three Florida schools had an average of 1,024 students, with 4–11% receiving special education services and 76 – 95% receiving free or reduced lunch services. The average class size across sites ranged from 19 to 25 and the teacher was the sole educator in the room. In Study 2, the schools, the schools were also diverse, with an average of 473 students per schools. Most schools (*n* = 6) served only elementary school students (K-6), but the others included middle school students.

Consultants in Study 1 were post-doctoral fellows (*n* = 2), master's level clinicians (*n* = 2) or graduate students in a master's or doctoral program in psychology (*n* = 5). Six identified as Caucasian, one identified as African American, and two identified as Hispanic. To ensure integrity to each consultation condition, facilitators attended a 3-day training and received weekly supervision throughout the trial.

Recruitment

All procedures were approved the research boards of all schools and universities involved. Recruitment in both studies occurred by inviting all teachers in participating buildings to an initial 3-h workshop that included content on classroom management and DRC procedures (see details in Owens et al., 2017, 2019). Teachers consented to the project at this workshop. To participate, teachers were invited to identify a target student who would benefit from the DRC, and obtain parent consent for implementation of the intervention in the context of the research study. Student eligibility differed across the two studies. In Study 1, parents and students completed a comprehensive evaluation with the investigators to confirm presence or risk of ADHD (see details in Owens et al., 2017). In Study 2, students with elevated scores on the hyperactivity/inattention problems or conduct problems subscales of the teacher-completed *Strengths and Difficulties Questionnaire* (SDQ; Goodman, 2001) were eligible (see Owens et al., 2019). The priority in both studies was the evaluation of teacher implementation behaviors. As such, the research team monitored some aspects of parent involvement but did not actively apply strategies to shape parent implementation behaviors.

Implementation strategies

Study 1 (standard and enhanced consultation conditions)

Teachers in this study were randomized (see successful randomization procedures in Owens et al., 2017) to either face-to-face standard consultation (n = 27) and face-to-face enhanced (n = 31); henceforth referred to as standard and enhanced. As can be seen from Table 1, teachers and consultants in both conditions participated in six events prior to launching the DRC: (1) the initial workshop, (2) a classroom management interview (3) a meeting to discuss and select target behaviors for the DRC (target behavior interview), (4) collection of baseline data, (5) a meeting to review baseline data and develop the DRC, and (6) a meeting with the child present to review and launch the DRC. Parents were invited to attend the launch meeting (48% attended in standard and 31% in enhanced). In both conditions, teachers were observed weekly, and met with the consultant on a biweekly basis (every other week) for up to eight consultation sessions. Details about the number, content, and duration of sessions were documented via consultation logs and consultation audio recordings. Teachers in each condition did not differ in the average number of sessions or average number of observations received (see Owens et al., 2017). Between sessions, teachers tracked the daily frequency of student target behaviors as part of implementing the DRC. Biweekly consultation sessions involved review of the student's progress on the DRC, review of data from the classroom observations, and feedback based on the observations. Teachers did not receive compensation for participating in consultation meetings.

In the standard condition, the bi-weekly consultation sessions adopted a behavioral problem-solving approach with brief performance feedback. The guiding principles for this condition were that performance feedback should be limited to 5–10 min and unless the teacher initiated discussion of teacher values, beliefs or other content, the problem-solving remained child-focused. This condition was meant to mirror best practice procedures (Frank & Kratochwill, 2014) and refrain from using active ingredients of the enhanced condition.

In the enhanced condition, motivational interviewing techniques were infused into each session (starting with a values interview during the classroom management interview). The bi-weekly consultation adopted a behavioral problem-solving approach but included techniques grounded in motivational interviewing and cognitive behavioral therapy to enhance teacher knowledge of behavioral principles and intervention (knowledge component), motivation, self-efficacy and beliefs related to intervention adoption and implementation (beliefs component), and skills in classroom management (skills component). Performance feedback was enhanced by focusing on the connection between teacher implementation behaviors and student outcomes and on discrepancies between teacher beliefs and behaviors (see Owens et al., 2017 for details).

Parents were invited to attend the DRC launch meeting. Some parents requested additional meetings with the consultant to discuss parenting related to the DRC. The teacher was not present at these meetings.

Study 2 (on-line condition)

This study included one condition, the interactive online supports condition. During the initial teacher workshop, the DRC was introduced and teachers were shown how to use the interactive website, referred to as the Daily Report Card.Online (DRC.O). The DRC.O website was developed to provide educators with an accessible, interactive, web-based platform to aid in the development and implementation of a DRC intervention (Mixon et al., 2019; Owens et al., 2019). The interactive DRC Wizard was designed to mirror face-to-face consultation, guiding teachers in selecting target behaviors, tracking baseline data, setting goals, and modifying the goals to shape student behavior over time. The website included video models, a graphing resource, downloadable resources, and a "Contact us" portal. If teachers had questions, a consultant would reply in 24 to 48 hours. There was no face-to-face consultation provided by the investigative team. Once teachers began a DRC, they were encouraged to implement the DRC and enter daily data for 2 months. To facilitate this, the research team sent e-mail prompts at specific points of implementation (e.g., after completing a pre-intervention SDQ, at DRC launch) and/or after a lapse in data entry. Details about the number and duration of website visits by teachers were documented via website analytics. Details about e-mail communication with teachers were documented via consultation logs.

Costs

Consistent with recommendations for conducting economic evaluations of intervention programs (Crowley et al., 2018), a societal perspective was taken for calculation of costs, with direct costs to the schools disaggregated. All direct costs were calculated for the time period including the initial workshop and the first 2 months of intervention delivery. In order to estimate costs associated with the implementation strategies, costs associated with the research components of the studies, such as research staff time and costs associated with administering the study instruments, were excluded. A two-month timeframe was selected given the evidence that the largest change in target behaviors occurs within the first 2 months of intervention (Holdaway et al., 2018; Owens et al., 2012).

Using workshop attendance and consultation logs from each study and website analytics from the second study, we calculated costs associated with (a) materials (used in the workshop and throughout implementation), (b) teachers' time (in the workshop, in consultation, on-line, and while data tracking), (c) consultants' time (in the 3-day training, in consultation, in observation, and meeting with families), and (d) parents' time in meetings. With regard to materials, the CostOut tool available through Columbia University's Center for Benefit–Cost Studies of Education was used to estimate costs of materials used in the workshop, consultation, and intervention delivery, including workshop materials and paper for bi-weekly newsletters distributed in the enhanced consultation. The cost of access to DRC.O was estimated to be 120 USD per student, consistent with the current payment package for this service. This is a conservative estimate, as this price point is the highest possible cost per student, given the flexible payment packages forthcoming for the DRC.O.

With regard to costs associated with teachers' and consultants' time, costs were calculated using the U.S. Bureau of Labor Statistics mean annual wages for these respective positions. The wage for teachers was estimated from the mean salary for teachers in 2018 ($62,200; 2019a), and this value was divided by 1,600, which assumes teachers receive a nine-month salary for 40-h weeks, resulting in an hourly rate of 38.88. USD The mean hourly wage of a school psychologist ($37.97; 2019a) was used to estimate costs attributed to the consultant. Opportunity costs related to parent time in meetings were calculated using the mean hourly wage across all industries ($27.23; 2019b). Wages were assumed to be equivalent across sites and studies in order for comparison, despite the regional differences in wages and costs of living. Although our sample includes international locations, all costs were estimated from publicly available data sources and were adjusted to 2018 U.S. dollars.

For costs related to teacher time using DRC.O implementation strategy, the website was programmed to collect data on teachers' time spent across various features. This feature allowed teachers to leave the website open while attending to other tasks, resulting in multiple outliers in time spent on the webpages. Outliers were identified using the Median Absolute Deviation approach (Leys, Ley, Klein, Bernard, & Licata, 2013) and identified outliers were Winsorized, or replaced by a value at the edge of the distribution. In the online condition, consultation was delivered via e-mail rather than in-person meetings. A log of all e-mail exchanges was maintained and, given evidence of the brevity of e-mail exchanges (Litmus, 2019; Ye, Rust, Fry-Johnson, & Strothers, 2010), it was estimated that time spent reading e-mails was less than 1 minute, and time spent typing an e-mail was approximately 3.5 minutes.

These above-described costs were calculated and summed for each child. For each implementation strategy, costs were estimated as total costs from a societal perspective, as well as direct costs to the school. Direct costs to the school were estimated as the sum of in-person training and material costs, assuming that other costs of consultation and implementation attributed to teacher or consultant time would be within the context of their school day duties as a teacher and school psychologist. Thus, their time during these tasks would not be monetized beyond what a school is already paying for typical practice.

Student outcomes

Student outcomes were defined as the change in student target behaviors. With consultation, teachers selected target behaviors (e.g., interruptions, out of seat) and were instructed to record the frequencies of the target behavior for at least three school days to establish a baseline. Teachers were then instructed to document the occurrence of each child's target behaviors daily. The magnitude of students' behavioral improvements were measured by single-case design effect sizes. For each DRC target behavior, the number of data points within each of the 2 months of intervention was calculated. If there were at least 3 days of baseline data and 10 days of data in the month, the change during that month of the intervention was quantified by calculating Tau-U and $Tau_{nonoverlap}$ (Parker, Vannest, Davis, & Sauber, 2011), a single-case effect size that accounts for possible trends during baseline. The $Tau_{nonoverlap}$ was used to calculate the effect unless the baseline tau value was ≥10, in which case Tau-U was used to correct for the baseline trend.

Analytic plan

Cost estimates

Costs were estimated as a sum of each implementation strategy, the average cost per participant, and the marginal cost. Marginal costs are an estimate of the cost of providing the intervention to one additional student in the classroom. Marginal costs reflect the variable costs of the program or costs attributable to each participant (Crowley et al., 2018). Thus, given that the cost to train a teacher and provide the teacher with materials for the intervention would not vary based on the number of students served, marginal costs were calculated as the average cost per student, minus training and material costs. For Aim 1, costs per student were calculated as the total cost of the condition divided by the total sample, consistent with the intent-to-treat approach. For Aim 2, the total cost of the implementation strategy was divided by the number of completers, defined as the number of students who had data entered for at least 10 days in either the first or second month of the intervention. Thus, 13 students were considered completers for standard consultation (48% of sample), 21 students were completers for enhanced consultation (68% of sample), and 25 students were completers for online condition (46% of sample). This threshold (10 of 20 school days in a month; or 50% compliance) was selected because it is consistent with methods used in previous studies (Owens et al., 2012) and because there is some evidence that a 51% compliance threshold represents a minimum threshold needed to change student classroom behavior (Owens et al., 2020).

Cost-effectiveness estimates

To calculate the cost-effectiveness of each implementation strategy relative to typical practice conditions (Aim 3), the estimated average cost per student was divided by the average effect size per student. A small portion of students ($n = 16$) had inadequate Month 2 data to calculate the Tau effect size, and for these students, Month 1 Tau effect sizes were imputed to Month 2 effects given evidence that Month 1 effects tend to remain stable or even increase into Month 2 most students (Owens et al., 2012). Given that Tau values between.20 and .60 represent a moderate effect and available DRC benchmarks for response to treatment at 2 months fall within this range (e.g., Holdaway et al., 2018), incremental cost-effectiveness ratios (ICER) are presented as ratios of the cost per .40 Tau effect size.

An ICER represents the average cost of the implementation strategy beyond that of typical practice, divided by the average effectiveness. The following formula was used to calculate the ICERs presented in this study:

$${\rm{ICER = }}\left({{{\rm{C}}_{\rm{A}}}{\rm{- }}{{\rm{C}}_{\rm{B}}}} \right){\rm{/}}\left({\left({{\rm{Tau\ effect\ size}}} \right){\rm{*}}{\rm{.40}}} \right)$$

where C_A is the average cost of the consultation package in question per student, C_B is the cost of treatment as usual, the Tau effect size is the average improvement in target behaviors relative to baseline, and the effect size is multiplied by .40 to allow the ICER to be interpreted as a moderate improvement per student. Thus, the ICER can be interpreted as the per-student cost of the implementation strategy required in order to achieve a moderate improvement in the DRC target behaviors. Thus, lower ICERs indicate that the approach costs less for the desired effect. Of note, the ICERs are equivalent between the overall sample and completers, given the 1:1 ratio by which non-completers decrease the per student cost to the degree by which they decrease the per student effect sizes. ICERs were not calculated between implementation strategies given that randomization to condition only occurred for two of the three conditions (i.e., standard and enhanced consultation in Study 1). Therefore, cost-effectiveness of each condition was estimated as relative costs and effects compared to typical practice, rather than relative to each other.

Sensitivity analyses

Because cost estimates are based on a variety of assumptions, current best practice standards for cost-effectiveness analyses include estimation of variability in the point estimates based on these assumptions (Crowley et al., 2018). Therefore, a series of sensitivity analyses were conducted in order to estimate the extent to which estimated ICERs were sensitive to variability in the model parameters, assumptions, or outliers. In the first sensitivity analysis, we examined the extent to which estimated costs and effects were driven by a small portion of extreme-cost cases. Thus, in subsequent analyses, the top 10%, then bottom 10% of students in terms of total cost were dropped from each condition. In the second sensitivity analysis, we examined the impact of wage variations on cost estimates by substituting the wage estimates with the 10th and 90th percentile wages for teachers and school psychologists as reported by the Bureau of Labor Statistics. Finally, a sensitivity analysis was conducted to assess for variations in the level of parent involvement. Thus, we calculated an estimate of per student costs if parents were not involved in the intervention and if parents were involved in each potential component (i.e., launch meeting, and three 1-h consultation meetings including both parent and consultant costs). For all comparisons described, independent samples *t*-tests were calculated to determine the statistical significance of observed differences in costs of the implementation strategies. The Bonferroni correction was applied to account for familywise error, resulting in an alpha of .004.

Results

Aim 1: costs of implementation strategies

Table 2 presents the cost per student for each component of the implementation strategy, the total cost per student, and the direct costs to the school per student (i.e., costs of in-person training and materials). In the full sample, the online system was less costly than either in-person approach. In terms of component costs, the online system had a unique advantage of requiring minimal consultant costs relative to the other two strategies. The most expensive component of the online system was the materials cost of using the DRC.O (i.e., 120 USD). When examining the direct cost to the school, the online system remained the least costly implementation strategy, followed by standard consultation and enhanced consultation which remained the most costly.

Aim 2: costs of implementation strategies for completers

To achieve Aim 2 we examined the costs of the intervention per completer, defined as a student who had at least 10 days of data tracked in their DRC during either of the first 2 months. Thus, we re-distributed the total costs of each implementation strategy across only those students who received at least a minimal amount of the intervention. Table 2 displays the costs of each implementation strategy by component per student who received the service. Unlike in Aim 1 analyses, standard consultation was the most expensive per completer, both overall and when examining direct costs to schools. The online system remained the least expensive per student.

Aim 3: cost-effectiveness of implementation strategies

For Aim 3, we calculated the ICERs, or cost per effect, of each implementation strategy relative to typical practice. Table 3 displays the ICERs per implementation strategy, presented as the cost per student in order to achieve a moderate response to intervention (Tau = .40). From the societal perspective, the standard condition costs 2,042.10 USD per student beyond typical practice per student to achieve moderate improvement in student target behaviors. Alternatively, the cost of the enhanced approach was 1,451.70 USD per student to achieve moderate improvement in each student's target behaviors. When considering the costs and effects relative to typical practice,

Table 2. Costs per student per implementation strategy.

	Average Cost per Student					
	Standard		Enhanced		Online	
	Unit	Cost	Unit	Cost	Unit	Cost
Materials Costs						
Teacher Binders	13 pg binder	$2.04[c]	20 pg binder	$2.60[c]	15 pg binder	$2.20[c]
Newsletters			16 colored pages	$5.92[c]		
DRC.O						$120.00[a, c]
Consultant Costs ($37.97/hr)						
Workshop	1 hr	$37.97[c]	1 hr	$37.97[c]	31 min	$19.69[c]
Interview	30 min	$18.99 [c]	50 min	$31.65[c]		
Target Behavior Selection	37 min	$23.16[a, c]	47 min	$30.65[a, c]		
DRC Development and Launch	1 hr 7 min	$42.53[a, c]	1 hr 37 min	$61.59[a, c]		
Consultation	1 hr 53 min	$71.46[a]	3 hr 26 min	$130.12[a]	15 min (e-mail)	$9.49[a]
Observations	44 min	$28.06[a]	52 min	$32.74[a]		
Meeting with Parents	42 min	$26.49[a]	44 min	$27.56[a]		
Meeting with Child	11 min	$7.21[a]	23 min	$14.61[a]		
Teacher Costs ($38.88/hr)						
Workshop	3 hr	$116.64[c]	3 hr	$116.64[c]	2 hr 4 min	$80.64[c]
Interview	30 min	$19.44[c]	50 min	$32.40[c]		
Target Behavior Selection	37 min	$23.98[a, c]	47 min	$30.46[a, c]		
DRC Development and Launch	1 hr 7 min	$43.42[a, c]	1 hr 37 min	$62.86[a, c]		
Online Training					29 min	$19.08
Consultation	1 hr 53 min	$73.18[a]	3 hr 26 min	$133.24[a]	4 min (e-mail)	$2.67[a]
Online Resource Use					32 min	$20.69
Data Tracking	2 hr	$78.10[a]	2 hr 19 min	$90.53[a]	50 min	$32.43[a]
Parent Costs ($27.23/hr)						
Launch Attendance	5 min	$2.27[a]	5 min	$2.27[a]		
Meeting with Consultant	42 min	$19.06[a]	44 min	$19.97[a]		
Per Student Materials Costs		$2.04		$8.52		$122.20
Per Student Consultant Cost		$255.87		$366.89		$29.18
Per Student Teacher Costs		$354.76		$466.13		$155.51
Per Student Parent Costs		$21.33		$22.24		

(*Continued*)

Table 2. (Continued).

	Average Cost per Student					
	Standard		Enhanced		Online	
	Unit	Cost	Unit	Cost	Unit	Cost
Total Program Cost		**$17,118**		**$26,777.18**		**$16,572.06**
Marginal Cost[a]		$438.92		$636.60		$164.59
ITT per Student Cost[b]	***n* = 27**	**$634.00**	***n* = 31**	**$863.78**	***n* = 54**	**$306.89**
ITT per Student Direct Cost to School[c]		$328.17		$412.74		$222.53
Completers per Student Cost[b]	*n* = 13	$1,316.77	*n* = 21	$1,275.10	*n* = 25	$662.88
Completers per Student Direct Cost to School[c]		$681.58		$609.28		$480.66

[a]Marginal costs reflect the cost for one more student to receive the DRC and were calculated as a sum of variable costs denoted by [a].
[b]ITT and Completers per student cost were calculated by taking the Total Program Cost divided by the number of total participants (ITT) and completers.
[c]Direct costs to school reflect the costs to a school beyond business-as-usual and were calculated as a sum of material and training costs denoted by [c].
If fringe benefits were included at a rate of 53.37% (CBCSE, 2019), the school psychologist hourly wage would be $58.23 and the teacher hourly rate would be $59.63. With fringe benefits included, the total program cost would be: Standard = $24,990.39; Enhanced = $39,280.10; Online = $21,894.30.

Table 3. Average effect sizes and cost-effectiveness ratios per implementation strategy.

	Standard	Enhanced	DRC.O
Average Tau Effect Size Overall	0.12	0.24	0.17
Average Tau Effect Size for Completers	0.26	0.35	0.37
Cost-Effectiveness Ratio (ICER)	$2,042.10	$1,451.70	$719.33

the online approach was the most cost-effective among the three strategies, with a societal cost of 719.33 USD per student to achieve a moderate improvement in target behaviors.

The ICERs presented in Table 3 are adjusted to be interpreted as the cost to achieve a moderate improvement per student in the respective condition. The portion of students achieving this moderate response to intervention by the second month was similar across groups, with 7 (26%) students in the enhanced condition, 9 (29%) students in the enhanced condition, and 12 (22%) students in the online condition achieving a moderate improvement (Tau ≥ .40).

Sensitivity analyses

Table 4 displays the results of the sensitivity analyses conducted to account for variability in cost estimates related to the assumptions made in the cost analyses. In order to examine whether group differences were driven by a small number of extreme-cost cases, the top 10% in terms of costs were dropped from each implementation strategy and the ICERs were calculated again. This procedure was repeated for the bottom 10% of cases. Similar to the main analyses, removal of the most extreme cases demonstrated that online consultation was the most cost-effective option, followed by enhanced consultation, followed by standard consultation. Removing the most costly cases did not result in significantly different cost or effect estimates across implementation strategies.

As can be seen in Table 4, if teacher and consultant wages are estimated at the 10th percentile, each implementation strategy would be significantly less costly than if teacher and consultant wages are at the mean. Similarly, if teacher and consultant wages are at the 90th percentile, each strategy would be significantly more costly than if teacher and consultant wages are at the mean. Regardless of the wage estimate used, conclusions regarding the cost-effectiveness across the three implementation strategies are consistent, such that the provision of the online consultation via DRC.O is the most cost-effective, followed by enhanced consultation, with standard consultation being the least cost-effective option.

Table 4 displays results of the sensitivity analysis examining the impact of parent involvement on cost estimates. Cost estimates are not significantly different from our estimates if parent involvement is assumed to be minimal. Each consultation package would be significantly more costly if parents were involved in the launch meeting and attended three 1-h consultation sessions. The on-line condition remained the least costly option if parents were assumed to be maximally involved.

Table 4. Results from the sensitivity analyses.

Removal of 10% Most Costly Cases			
	Standard	Enhanced	On-line
Average Cost per Student	$562.60	$776.28	$285.56
Average Effect per Student	0.11	0.20	0.15
ICER	$2,110.96	$1,579.48	$758.69
Removal of 10% Least Costly Cases			
	Standard	Enhanced	On-line
Average Cost per Student	$650.14	$892.41	$320.62
Average Effect per Student	0.14	0.26	0.17
ICER	$1,861.42	$1,354.68	$748.74
10th Percentile Wages			
	Standard	Enhanced	On-line
Average Cost per Student	$381.46*	$515.42*	$232.96*
ICER	$1,228.68	$866.24	$546.04
90th Percentile Wages			
	Standard	Enhanced	On-line
Average Cost per Student	$985.64*	$1,344.83*	$408.28*
ICER	$3,174.71	$2,260.17	$956.97
No Parent Involvement			
	Standard	Enhanced	On-line
Average Cost per Student	$588.81	$820.93	$306.89
ICER	$1,962.70	$1,368.22	$719.33
Maximum Parent Involvement			
	Standard	Enhanced	On-line
Average Cost per Student	$761.68*	$993.81*	$479.36*
ICER	$2,538.93	$1,656.35	$1,127.91

**p <.004. *P* values derived from *t*-tests comparing costs and/or effects from the sensitivity analysis to costs and/or effects from the intent-to-treat analysis.

Discussion

Using an ingredients-based approach and a societal perspective, we estimated the costs of three implementation strategies (for the initial workshop and across 2 months of implementation) and their cost-effectiveness relative to typical practice. In terms of costs beyond those of typical practice, the results reveal that the interactive online implementation strategy was the least expensive overall ($306.89 per student), followed by standard consultation ($634.00 per student), with enhanced consultation costing the most per student ($863.78 per student). When considering these costs in relation to the students' improvements in behavior, the costs for the desired effects were lowest for online consultation, followed by enhanced consultation, and, further followed by standard consultation. The ICERs reveal that (a) the online approach costs the least for the desired effect relative to the face-to-face conditions, and (b) although more costly, enhanced individualized strategies may produce a greater effect than standard consultation characterized by a one-size-fits-all approach. These findings advance our knowledge about the costs of implementation strategies and offer support for some assumptions about technology-assisted supports and enhanced individualized consultation.

First, to our knowledge this is the first study to put a price on various implementation strategies. Prior studies have revealed the costs of intervention packages per youth at-risk of ADHD, including a 2-month trial of high quality medication management ($2,022 or 2,230 USD in 2019 dollars), or a 2-month trial of school-based behavior therapy ($1,706 or 1,881 USD in 2019 dollars; Page et al., 2016), yet this is the first study to demonstrate the potential cost-savings utility of consultation for school-based interventions. Given the limited use of targeted classroom interventions by elementary school teachers (e.g., Martinussin et al., 2011) and the high variability in implementation when used (e.g., Fabiano et al., 2010; Owens et al., 2008), finding effective, feasible, and affordable implementation strategies is critical to ensuring that students receive needed intervention. Our findings allow school administrators to consider the extent to which the three approaches used in these studies fit within their school budgets. Considering the high annual societal costs associated with special education services per student with ADHD ($5,007, or 5,842 USD in 2019 dollars; Robb et al., 2011), future research should examine the extent to which the costs of these implementation strategies may reduce the need for, and thus costs of, special education for some students.

Second, we found support for two important hypotheses. Namely, the individualized enhanced strategy was more costly, yet students whose teachers used this strategy experienced the greatest effects. Thus, in the enhanced consultation strategy, increased costs were associated with increased positive effects (i.e., schools may get their money's worth). This is an important finding given the number of enhanced approaches that have been evaluated in recent years (e.g., Bradshaw et al., 2018; Collier-Meek et al., 2019; Conroy et al., 2015). With further study of these approaches, we may be able to identify the mechanisms through which each implementation strategy operates to produce the desired implementation outcome (Lewis et al., 2018) and further streamline how we train consultants in the approach. Similarly, we found support for the claim that technology can lead to efficiencies that are cost-effective, as this produced the smallest ICER, or the per-student cost required to achieve a moderate improvement in the DRC target behaviors. These conclusions regarding cost-effectiveness did not change with the inclusion of the sensitivity analysis, suggesting that these findings are robust against variations in costs attributable to regional or staffing differences. Given this finding, cost-effectiveness analyses of the use of other technologies in consultation (e.g., bug-in-the-ear and Swivel cameras; Grygas Coogle, Ottley, Rahn, & Storie, 2018) and video-conference technologies (e.g., Schultz et al., 2018) are warranted to determine which technologies provide cost-effective implementation strategies.

These findings, coupled with the emerging evidence that individually tailored approaches may produce benefits for some teachers (i.e., those with barriers to integrity) but may be unnecessary for other teachers (e.g., teachers who can leverage technology; those without barriers to integrity), suggests that additional research on individualized approaches and on the use of technology are fruitful pursuits. Indeed, school administrators may find cost efficiencies in matching implementation strategies to teacher needs, as being able to offer technology to those who can achieve effects without expensive face-to-face consultation and reserving the more costly enhanced consultation to those who need such support can maximize outcomes for dollars spent. Thus, it may be profitable for researchers to examine possible moderators of cost-effectiveness (e.g., teacher implementation integrity) and devote efforts toward the development of reliable and valid tools for measuring teacher characteristics that may predict implementation integrity and/or specific professional development needs (Owens, Allan, Hustus, & Erchul, 2018; Owens et al., 2017). Such research could facilitate the identification of teacher characteristics that may moderate response to consultation and/or prioritize groups of teachers for specific types of support. Such specificity could help school personnel expend consultative resources efficiently.

It is important to note that we calculated ICERs to represent a ratio of the cost per .40 Tau effect size, a moderate effect size. Finding a meaningful outcome in cost-effectiveness studies can be a challenge. We selected this outcome, given the evidence that this benchmark can be expected after 1 and 2 months of intervention (Holdaway et al., 2018; Owens et al., 2012). Further, using information from other studies (Mixon et al., 2019; Owens et al., 2012, 2019), these effect sizes represent (a) change in student behaviors that teachers view as a top priority, (b) changes that move students from the clinically significant range to near normative range on teacher rating scales, and (c) 40% to 60% reductions in negative behaviors relative to baseline levels. Although effect sizes should be interpreted in the context of student needs, goals, history, and context (Vannest & Ninci, 2015), we believe that this represents a meaningful and interpretable outcome. Nonetheless, additional research is needed to identify outcomes that can be used across studies to enhance the interpretability of ICERS.

Lastly, parent involvement in the current implementation strategies was relatively limited, with few parents engaging in offered meetings. Given the priorities of the studies from which our data were drawn, data on parent involvement were limited in the on-line condition. Our sensitivity analysis demonstrated that costs of each strategy would be significantly greater if parents were more involved in implementation. Given that greater parent involvement in school-based interventions has been associated with improved effects (Vannest et al., 2010), research is needed to examine whether these increased costs impact the cost-effectiveness of these interventions. Further, cost-effectiveness estimates may be even more favorable under different circumstances and/or with technological advances that facilitate more parent involvement.

Limitations

These findings should be considered within the context of the study's limitations. First, the current study used two separate samples to estimate costs and effects of the three implementation strategies. This lack of randomization precluded our ability to make direct comparisons between each condition, and therefore all cost-effectiveness indices represent the condition's comparison to typical practice. Future studies are warranted to utilize randomization processes in order to directly compare across implementation strategies and eliminate concerns related to potential inherent group differences. Second, all costs related to wage are estimates based on U.S. estimates from publicly available resources. These estimates may not be representative of different staffing decisions (e.g., having a school counselor rather than a school psychologist) or regional variations in wages, and therefore calculated costs should be interpreted as estimates that are likely to vary in real-world settings. Additionally, these estimates were calculated using U.S. wage estimates, although a portion of the sample was from Canada. The multi-national nature of our sample serves as a strength, yet the current cost estimates may not generalize across countries. Although detailed time estimates from timesheets were used to estimate wages, e-mail logs did not include estimates for time spent on e-mails. Estimates for time in consultation e-mails were best-estimates based on currently available data regarding time spent on e-mails and may not accurately represent the actual time spent in e-mails. However, each consultant and teacher would have needed to spend an additional 3.5 hours on e-mails per student in the online condition in order to make it more costly than other conditions. Given this high estimate, it is unlikely that potential variations in these estimates would impact our conclusions. As with many cost-estimate studies, some costs related to the consultation may not have been captured, such as wage estimates related to systems-level administrative support, informational technology support staff time, overhead costs, or travel time if teachers or consultants need to travel to the trainings or consultant meetings. These costs may be important considerations for the overall societal costs, yet they are unlikely to change the direct costs to schools. Lastly, best practices for single subject research (Kratochwill et al., 2010), recommend having 5 days of baseline data. Given the challenges to meeting this standard in practice, we relaxed this criterion to maximize our sample size.

Conclusions

Our findings support the assumptions related to the cost-effectiveness advantages of technology-based interventions. The findings also suggest that there may be substantial cost-effectiveness advantages to prescribing specific strategies to teachers based on their likely responsiveness. Enhanced face-to-face consultation appears to be an effective and expensive approach to helping teachers implement a DRC. Thus, identifying teacher characteristics that moderate response to type of consultation will be an important next step in this line of research.

Compliance with Ethical Standards

Procedures in both studies were approved by the Institutional Review Boards at all universities and within all school districts. All procedures were performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Disclosure statement

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