The Effectiveness of Two Implementation Strategies for Improving Teachers' Delivery of an Evidenced-based HIV Prevention Program

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Research

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Abstract

Background: Effective implementation strategies are needed to enhance the success of evidence-based prevention programs. The current study evaluates the effects of two implementation strategies on teachers' implementation of an evidenced-based HIV intervention.

Methods: Using our 7-item Pre-Implementation School Screening tool, we identified teachers who were at-risk for not implementing the Focus on Youth HIV-risk reduction intervention curriculum which targets middle and high school youth. After completing a two-day curriculum workshop, 84 low- and moderate-performing teachers were randomly assigned to one of four experimental conditions and were asked to teach the intervention curriculum for nearly two months. This optimization trial examines the impact of two implementation strategies including biweekly monitoring/feedbacks (BMF) and site-based assistance/mentorship (SAM). The primary outcome is implementation fidelity defined as number of core activities taught. General linear model was used to examine the association of the implementation strategies with implementation fidelity.

Results: BMF and SAM were significantly associated with teachers' implementation fidelity. Teachers who received both BFM and SAM taught the greatest numbers of core activities, followed by teachers who received either BMF or SAM. Teachers who did not receive BMF or SAM taught the lowest numbers of core activities (15.0 vs. 7.9 vs. 6.9 vs. 4.1, $p < 0.001$). Teachers' confidence in implementing five core activities, attitudes towards sex education in schools, and perceived principal support were significantly related to increased self-efficacy, which in turn was related to teachers' fidelity of implementation. Teacher full attendance at the training workshop and teachers' sustained implementation of FOYC in the prior school year were related to increased implementation fidelity.

Conclusion: BMF and SAM are effective in promoting teachers' implementation of youth evidence-based interventions. Researchers and future program implementers should consider teacher training, teachers' attitudes towards sex education, perceived principal support and self-efficacy when attempting to maintain the effects of teacher-delivered interventions in schools.

Contributions To The Literature

1. Our study developed two theory-driven implementation strategies which demonstrated significant effects on teachers' fidelity of implementation: biweekly monitoring and feedbacks (BMF) and site-based assistance/mentorship (SAM).
2. Selection and training of motivated school coordinators and mentors are critical for successful program implementation.
3. Lessons learned from the study may inform the design and/or implementation of other teacher-delivered school-based health promotion programs.
4. These findings address recognized gaps in knowledge regarding effective implementation strategies and teacher implementation support.

Introduction

Implementation of sustainability of evidence-based intervention

Over the past decade, multiple disciplines have embraced the importance of moving evidence-based interventions (EBIs) into community settings in order to benefit society [1], contributing to the development of the discipline of “implementation science”. As a rapidly growing field, implementation science has focused on factors and strategies that influence the adoption and implementation of EBIs in real-world settings [2]. Despite significant advancements in understanding the implementation of EBIs, little is known about the extent to which EBIs in community settings are sustained or whether their program impact is maintained after the initial implementation. The many challenges encountered in implementation in real-world settings result in implementation delivery quality issues which impair program outcomes [3, 4] and/or discontinuation or abandon of EBIs in community settings [5]. Implementation of EBIs in the school setting remains low [1]. Prevention programs conducted in schools outside of efficacy trials are typically not implemented with sufficient fidelity, resulting in reduced program effectiveness [6, 7].

Factors influencing implementation fidelity of EBIs in school settings

Numerous studies have examined factors influencing implementation of school-based prevention programs and identified a range of factors that are associated with implementation fidelity: teacher training, program characteristics (addresses students’ needs), teacher characteristics (belief in the program, high motivation), and the provision of ongoing technical assistance [8–10]. Little and colleagues [11] found that comprehensive teacher training significantly increased teachers’ self-efficacy, which resulted in an increase in implementation fidelity. Comprehensive implementation support (e.g., 1-day teacher training workshop, onsite coaching, web-based support, and technical assistance) was found to be associated with higher implementation fidelity, which resulted in greater program impacts on intention to use drugs compared with the 1-day workshop training [12]. Teacher’s experience of program support from the head teacher was positively related to implementation fidelity, whereas teacher’s experience of general support did not enhance implementation [13]. Prior research suggests that credentialed health education teachers are more comfortable teaching sex-related topics, and deliver a greater proportion of intervention components than teachers who do not have this credentialing [12, 14, 15]. Teachers positive attitudes towards sex education predicted the delivery of sex education in schools [16]. Research suggest that the low autonomy of teachers in school may discourage their implementation of prevention programs [17]. Overall, the support of school administrators, program priorities, the motivation of the curriculum coordinator and the values and confidence of individual teachers are primary factors which shape the implementation of school-based prevention program [18].

Contrarily, factors inconsistent with these supporting elements (such as lack of school time, competing priorities) undermine implementation [19]. Local adaptations of interventions, variations in teacher adherence and competence, lack of available training and technical support, limited local resources for supporting the intervention, and staff absence and turnover were identified as barriers to maintaining implementation fidelity in real life contexts [20–22]. These factors can diminish teachers' commitment and impair program effectiveness.

Implementation strategies enhancing teachers' implementation of EBIs in schools.

The implementation approach "*Fidelity through Informed Technical Assistance and Training* (FITT) [23] addresses threats to implementation fidelity through monitoring of implementation data provided by teachers and observers, allowing for feedback and evaluation. In one study, the investigators reported that through the use of the FITT approach, the school system enjoyed an overall 98% curricular adherence [23]. Previous research showed that teachers who received more performance feedback had higher levels of implementation over time in comparison with teachers who received less feedback [24]. Further, growing literature supports the utility of a social-support network for teachers confronting similar implementation challenges [25, 26]. Such clusters/networks of individuals have been defined as "Communities of Practice (CoP)" [27]. Peer-based mentoring methods have been used in Norwegian schools, as teachers get together in organized groups to dwell on topics or problems they encountered during implementation in a reflective, critical and constructive way [28]. Coaching has also shown promise in improving implementation fidelity of classroom-based interventions [24]. Side-by-side coaching during class group instruction improved teachers' implementation fidelity [29]. Web-based coaching interventions improved teachers' suboptimal implementation behavior [30]. Video guidance/support has been found to improve teachers' fidelity of initial implementation of EBIs in schools [31].

Establishing Bahamas culturally appropriate strategies to improve teachers' implementation.

Our team collaborated with The Bahamas Ministry of Education (MOE) to identify and pilot several culturally appropriate implementation strategies. Based on the principles of CoP, the MOE created a group mentorship program to deploy the strength of high-performing teachers to help teachers who are struggling entitled "Site-based assistance/mentorship" (SAM). High-performing teachers served as team leaders and provided guidance and onsite assistance to low- and moderate-performing teachers to increase the skills and self-efficacy of the latter [11]. SAM is a two-tiered peer mentorship program. General guidance and biweekly meetings were established to provide Health and Family Life Education (HFLE) teachers the opportunity to meet with the team leader biweekly to discuss their progress, identify challenges these teachers are experiencing, and provide guidance during the meeting. The team leader

promoted group activities and enhanced interaction among teachers in these meetings. Onsite assistance and observation was also provided for at-risk or moderate-performing teachers to observe while the session is being taught by a high-performing teacher in the classroom. Teachers who still had difficulties in teaching sensitive topics were observed in the classroom by the team leader who provided onsite assistance. These strategies have evolved as part of The Bahama's school system's culture to support new/challenged teachers. An additional program, entitled "biweekly monitoring and feedback (BMF)", was offered to all HFLE teachers. Teacher implementation was monitored by School Coordinators biweekly with feedback provided to the teachers by the HFLE Senior Curriculum Officer as per MOE policy. Decisions regarding the need for change will be made based on data by the Implementation Committee. High performing and at-risk teachers are identified through biweekly "real-time" implementation monitoring [23] and a brief Pre-Implementation Screening Tool developed by our team [32].

Methods

HIV intervention ("FOYC+CImPACT"):

Focus on Youth in the Caribbean ("FOYC") is an evidence-based, life skills curriculum designed to reduce risk taking behaviors related to HIV/STI transmission and teen pregnancy. Woven throughout FOYC is a decision-making model that provides guidance and practice in problem solving with a focus on how to obtain factual information on sexual health. Caribbean Informed Parents and Children Together ("CImPACT") is a single session intervention including a 22-minute educational video filmed in The Bahamas which focuses on effective parent-adolescent communication and listening strategies related to difficult topics and safe-sex followed by two role-plays for the parent and youth, a discussion, and a condom demonstration [32]. FOYC+CImPACT was adapted from Focus on Youth (FOY) plus Informed Parents and Children Together (ImPACT). FOY+ImPACT was selected to be part of the Centers for Disease Control and Prevention's "Diffusion of Effective Behavioral Interventions (DEBI)" Portfolio.

Teacher training:

Eighty-four grade six teachers who teach Health and Family Life Education (HFLE) classes in 24 schools on New Providence (the island where the capital city is located) completed a two-day teacher training workshop in October 2018. The training was provided by a diverse team of trainers and project staff, including three Bahamian Focus on Youth trainers who have extensive experience implementing FOYC+CImPCT and a US training specialist with expertise preparing educators to lead FOYC+CImPCT with remote and face-to-face training delivery. The training focused on increasing the teachers' curriculum knowledge, building positive attitudes about the curriculum, and increasing skills and comfort to deliver the curriculum. Consistent with the Focus on Kids training guidelines, the training was comprised of clear expressed objectives, short lecturettes, group discussions, videos from the curriculum, skill and curriculum demonstration, active learning through skill practice, role plays and teach backs – all recommended as elements as effective skill-based training [33]. Additionally, the training aligned with

Adult Learning Theory in that the teachers were invited to give input into the training, they participated in several problem solving activities in an environment in which it was safe to make mistakes, and findings from any research in which they were involved could be immediately applied to their work in the classroom [34] . The teacher training covered: 1) the history and prevalence of HIV and HIV prevention in The Bahamas; 2) overview of FOYC including the research showing its effectiveness; 3) a “walk-through” of each session of FOYC with modeling of the “core” activities (activities considered to be critical to the success of FOYC, such as the Family Tree activity) and implementation guidance on how to avoid common pitfalls and maximize the impact of each session; 4) a didactic question-and-answer period regarding menstruation, contraception and condom-use; and, 5) a modeling of CImPACT, followed by implementation guidance. All teachers were given a copy of the FOYC teacher training manual. Teachers completed their consent forms, Measures C (Workshop Pre-evaluation), D (Workshop Post-evaluation), and E (Impression before Teaching) at the training workshop.

All participating teachers were presented a FOYC+ CImPACT 24/7 flash drive for “point-of-care” guidance as they prepared the lessons. FOYC+CImPACT 24/7 is a media-rich digital training program [35] accessible anytime, anywhere via DVD delivery. Such guaranteed access is important to teachers as the internet connection is sometime unreliable across all of the islands constituting The Bahamas. FOYC+CImPACT 24/7 was based on a similar evidence-based training and implementation support resource [36] and provides teachers with information and teaching points about each of the sessions, and intensive modeling and practice designed to develop key skills, such as answering sensitive questions, creating a safe and inclusive classroom, facilitation skills, etc. Teachers were oriented to the 3-hour DVD-based training during their in-person training. Providing accessible implementation support for educators is critical to correct curriculum implementation as it provides assistance when needed [37].

Teacher stratification:

In preparation for the optimization trial in New Providence in Year 1, the US-Bahamas investigative team identified 81 low-performing and moderate-performing teachers and 10 high-performing teachers using our 7-item Pre-implementation School Screening tool. This stratification of teachers into three performance-levels was based on the teachers’ performance during the implementation study period (2011-2016) of a prior study using the same curriculum and teachers, and information regarding their continued implementation of FOYC in their classes over the past year.

In addition, the team held sessions with teachers and administrators from each school to ascertain: their comfort level regarding the curriculum; knowledge and exposure to the FOYC curriculum prior to the 2-day training; and, the execution or completion of the FOYC activities post training (November 2018-January 2019). This information allowed further identification of teachers who were most at-risk for implementation.

School coordinator and mentor training:

Twenty-four school coordinators (including two national school coordinators) were identified and trained for the purpose of tracking teachers' implementation and progress biweekly, collecting teacher's measures, and identifying and reporting issues/problems to the research team in New Providence. The coordinators also ensured that teachers were available for the training workshops and coordinated meetings within their schools.

In addition, high-performing teachers (mentors) were trained to provide "site-based assistance and mentorship" to at-risk and moderate-performing teachers. Mentors were trained for the purpose of identifying the challenges faced by teachers, assisting teachers in preparing for intervention sessions, promoting group activities and interaction among teachers, observing teachers teaching the session, modeling and providing guidance to improve curriculum delivery.

The school coordinator and mentor trainings were conducted by two Bahamian trainers who have extensive experience implementing FOYC+CImPACT. The school coordinator and mentor training sessions lasted about 4 hours and 3 hours respectively.

School-based intervention assignment.

Eighty-one at-risk and moderate-performing teachers in 24 schools were randomly assigned to four conditions of the Optimization trial in middle January-March 2019, using school-based randomization to avoid possible contamination. More schools were assigned to the control condition or to BFM because only six high-performing teachers/mentors were available for the optimization trial. Several high-performing teachers were unable to assist other teachers because of their workload/schedule. Nine schools were assigned to the control condition and nine schools to BFM only. Four schools were assigned to SAM only and two schools were assigned to both BFM and SAM condition. The research protocol was approved by the University of Massachusetts Medical School Human Investigation Committee and the Institutional Review Board of the Bahamian Princess Margaret Hospital, Public Hospitals Authority.

Measures

Implementation fidelity.

To assess implementation, all teachers were asked to complete a Teacher Implementation Checklist specific for each of the eight sessions of FOYC and CImPACT parent session after they had taught the session. The checklist includes the 30 activities identified by the developers as "core elements". The teachers documented the activities that they covered in each session. Implementation dose was defined as the number of the 30 core activities that were taught during the optimization trial period (lasting two months, middle January to middle March, 2019).

Teacher's Characteristics, Training Experience, and Perceptions. A pre-implementation questionnaire was used to collect information described in the extant research as influencing fidelity of intervention implementation: teacher's level of formal education; years as a teacher; teacher's attendance at FOYC training workshop; teachers' perceptions of the importance of HIV prevention (very important, somewhat important, or not important) for grade six students in their schools; teacher's comfort level in teaching the FOYC+CImPACT intervention; and, teacher's sense of "ownership" of the curriculum (i.e., perceiving it as a "Bahamian intervention") In bivariate analyses, responses for years as a teacher were grouped into three collapsed categories (1–10 years, 11-20 years, and >20 years), and two categories for perceptions of FOYC as a "Bahamian intervention" (very or somewhat/not at all) due to low frequencies in some categories.

Pre-implementation questionnaires assessed teachers' autonomy (four items) [38], perceived principal supportiveness (four items) [39,40], teachers' confidence teaching/discussing five topics such as condom use, teen pregnancy and HIV/AIDS (five items) [41], teachers' attitudes towards sex education in schools (eight items) [16], and teachers' self-efficacy in teaching the FOYC+CImPACT intervention (three items) [42]. Answers are given on a likert scale with five options (ranging from 1, totally disagree to 5, totally agree). Mean scores ranged between 1-5, with higher scores equating to more favorable perceptions/attitudes. The internal consistency of the scales is adequate (Cronbach's alpha: autonomy, α=0.79; principal supportiveness α=0.80; confidence, α=0.87; attitudes towards sex education, α=0.77; self-efficacy α=0.73)

Analysis

The effect of the implementation strategies (BMF and SAM) on teachers' implementation was assessed using bivariate and multivariate statistics. ANOVA was used to compare the difference in number of core activities taught by the four groups of teachers. Multiple comparisons were conducted to examine the difference of all possible pairwise means. The effect of implementation strategies on teachers' implementation, which was found to be significant at the bivariate level, was further examined using a general linear model (GLM) controlling for potential confounders, including teachers' baseline perceptions and number of core activities taught before the start of the optimization trial. In addition, Pearson correlation analysis was conducted to examine the associations among teachers' perceptions (autonomy, principal supportiveness, attitudes towards sex education in schools, confidence, and self-efficacy) and teachers' implementation. Finally, a parsimonious structural equation model was constructed to examine the relationships among factors influencing teachers' fidelity of implementation.

Results

Association between Teacher's Characteristics, Training Experience, Perceptions, and Teacher's Fidelity of

Implementation.

Table 1 presents the average number of core activities taught by teachers before or during the optimization trial according to different personal characteristics and training experience. Teachers who completed the FOYC training workshop taught more core activities before the optimization trial (in the fall semester) than did the teachers who did not attend or only attended part of a training workshop (8.36 vs. 4.88, $t = 2.19$, $P < 0.05$). Teachers who reported that they had taught several sessions or some activities of FOYC in the past 12 months (prior school year) taught more core activities during the optimization trial period than did the teachers who did not teach any activities of FOYC in the past 12 months (7.57 vs. 7.44 vs. 3.87, $F = 6.08$, $P < 0.01$). Teacher's comfort in teaching FOYC and CImPACT and in leading the roleplays and teachers' sense of ownership of the FOYC curriculum (e.g., as a "Bahamian intervention") was positively associated with implementation. Teacher's education, years as teacher, and teachers' perceptions regarding the importance of HIV prevention for grade six youth were not associated with the implementation of FOYC.

Table 1
Association between teacher's characteristics, training experience and number of activities taught before and during the optimization trial among 81 grade six teachers

Variables	No. of teachers#	No. of core activities completed before the optimization trial	No. of core activities completed during the optimization trial
Education			
Associate degree/teaching certificate	7	9.29(6.40)	8.00(5.83)
Bachelor's degree	56	7.11(5.64)	5.88(4.14)
Master's degree	14	6.50(6.76)	7.43(4.78)
F test		0.54	1.23
Total years as teacher			
1～10 years	21	5.71(4.26)	6.71(4.65)
11～20 years	28	7.57(6.83)	6.68(4.55)
>20 years	32	7.97(5.76)	6.23(4.49)
F test		1.00	0.10
Attended a FOYC training workshop			
Yes	66	7.59(6.04)	6.47(4.33)
No	14	5.57(4.24)	7.29(5.61)
Student's t test		1.19	0.61
Fully attended training workshop			
Yes	55	8.36(5.99)	6.69(4.53)
No	23	4.88(4.70)	7.47(4.67)
Student's t test		2.19*	0.62
Taught FOYC in the past 12 months			
No	23	5.78(7.23)	3.87(3.24)
Yes, taught several sessions	44	8.52(5.03)	7.57(4.25)
Yes, only taught several activities	9	5.56(3.54)	7.44(6.09)

Variables	No. of teachers#	No. of core activities completed before the optimization trial	No. of core activities completed during the optimization trial
F test		2.28	6.08**
Meaningfulness of FOYC for grade 6 youth in your school			
Very meaningful	72	7.57(5.79)	6.33(4.56)
Somewhat meaningful	5	4.60(6.54)	9.20(4.32)
Student's t test		1.10	1.36
Comfort in teaching FOYC			
Very comfortable	50	8.50(6.39)	6.36(4.35)
Somewhat or not comfortable	27	5.15(3.90)	7.19(5.12)
Student's t test		2.85**	0.75
Comfort in conducting CImPACT			
Very comfortable	22	9.64(7.36)	5.36(3.39)
Somewhat or not comfortable	52	6.10(4.66)	6.79(4.96)
Student's t test		2.09*	1.43
Comfort in leading the roleplays			
Very comfortable	47	8.45(6.26)	6.96(4.13)
Somewhat or not comfortable	31	5.61(4.65)	5.77(5.04)
Student's t test		2.16*	1.13
FOYC is a Bahamian curriculum			
Very	51	8.24(6.34)	7.14(4.72)
Somewhat or not at all	27	5.67(4.25)	5.59(4.29)
Student's t test		2.13*	1.42
Note: * P < 0.05; ** P < 0.01. #. 1–7 teachers had missing values in some variables.			

Effects of the implementation strategies on teachers' degree of implementation.

As shown in Table 2, 81 teachers from 24 schools in New Providence participated in the optimization trial. Results from bivariate analysis indicate that teachers who received both BFM and SAM taught the greatest numbers of core activities, followed by teachers who received either BMF or SAM, with teachers who did not receive BMF or SAM teaching the lowest numbers of all activities during the optimization trial period (15.0 vs. 7.9 vs. 6.9 vs. 4.1, $p < 0.001$). There was no significant difference in number of core activities taught by teachers who received BFM and teachers who received SAM.

Table 2
Number of core activities taught by teachers during the optimization trial period

Intervention group	Number of schools	Number of teachers	Core activities taught (Mean ± SD)	F	P	Paired comparisons
1. Teachers did not receive BFM or SAM	9	31	4.13 ± 3.87	13.20	< .0001	(1, 2) (1,3) (1, 4) (2, 4) (3, 4)
2. Teachers received BFM	9	31	6.94 ± 3.69			
3. Teachers received SAM	4	14	7.93 ± 3.93			
4. Teachers received both BFM and SAM	2	5	15.00 ± 3.54			
Note: BFM= "biweekly monitoring and feedback"; SAM= "site-based assistance and mentorship."						

As shown in Table 3, GLM analysis of the number of core activities taught by the teachers during the optimization trial period yielded a significant main effect of intervention ($p < 0.001$) after controlling for teachers' self-efficacy, teachers' attitudes towards sex education in schools, whether teachers had taught several sessions or some activities of FOYC in the past 12 months (prior school year), and number of core activities taught before the start of the optimization trial. In addition to intervention status, teachers' baseline self-efficacy ($P = 0.014$) and teachers' implementation behavior in prior school year ($P = 0.009$) were predictive of implementation fidelity during the optimization trial. The results of pairwise comparisons indicated that teachers who received both BFM and SAM demonstrated highest performance (taught 15 core activities on average), followed by teachers who receive BMF or SAM (7–8 core activities on average). Teachers who did not receive BMF or SAM exhibited the lowest implementation activities (4 core activities on average).

Table 3
General linear model analysis on the effects of implementation strategies on number of core activities taught by teachers during the optimization trial period

Source of variance[a]	Type III sum of square	df	Mean square	F	P value
Model	625.61	11	56.87	4.51	< 0.0001
Intervention group	241.72	3	80.57	6.39	0.0009
Education	9.24	2	4.62	0.37	0.6948
Taught FOYC in the prior school year	93.63	1	93.63	7.43	0.0086
Number of core activities taught before the trial (first term of current school year)	6.10	1	6.10	0.48	0.4896
Self-efficacy	82.21	1	82.21	6.52	0.0135
Attitudes towards sex education	14.56	1	14.56	1.16	0.2873
Attendance at the training workshop	10.89	1	10.89	0.86	0.3567
Perceived principal support	4.28	1	4.28	0.34	0.5623
Error	680.52	54	12.60		
Corrected total	1306.12	65			
Dependent variable: number of core activities taught during the optimization trial period. $R^2 = 0.48$					

Relationships among factors influencing teachers' fidelity of implementation.

The strength of associations between factors influencing teachers' self-efficacy and implementation was examined using Pearson correlation coefficients (Table 4). Teachers' confidence in teaching five core activities, attitudes towards sex education, and perceived principal support were significantly related to increased self-efficacy ($r = 0.25–0.48$, $P < 0.05$ or $P < 0.001$), which in turn was related to teachers' degree of implementation ($r = 0.33$, $P < 0.01$). teachers' confidence is significantly related to teachers' positive perceptions of sex education in schools ($r = 0.34$, $p < 0.01$). Teachers' confidence, perceptions of sex education, autonomy and perceived principal support were not significantly related to teachers' degree of implementation.

Table 4
Bivariate correlation among factors influencing teachers' self-efficacy and implementation

Variables	1	2	3	4	5	6	7	Mean	SD
1. Confidence	1.00							4.25	0.70
2. Attitudes towards Sex education in schools	0.34**	1.00						3.57	0.58
3. Autonomy	0.07	-0.01	1.00					3.97	0.64
4. Principal support	0.02	0.02	-0.21	1.00				3.71	0.61
5. Self-efficacy	0.46***	0.48***	0.01	0.25*	1.00			3.60	0.73
6. Attendance at training workshop	0.02	0.22	-0.08	0.02	0.27*	1.00		1.78	0.42
7. Number of core activities taught	0.06	-0.05	0.04	0.00	0.33**	0.25*	1.00	7.15	5.81

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. SD = Standard deviation. Score range:1 ~ 5 for confidence, sex education, autonomy, principal support and self-efficacy.

Structural equation modeling demonstrated relationships among factors and their direct and indirect effect on fidelity of implementation [i.e., number of core activities taught before the trial (first term of current school year)] (Fig. 1). There were four manifest exogenous variables and two manifest endogenous variables (e.g., self-efficacy, implementation fidelity) in the model. The overall fit of the revised path model was excellent (CFI = 0.99, TLI = 0.93, RMSEA = 0.07, chi-square = 1.57 p = 0.21; SRMR = 0.02). The analysis revealed an R^2 value of 0.42 for teachers' self-efficacy and of 0.21 for fidelity of implementation.

In the revised model, teachers' confidence, positive attitudes towards sex education in schools, perceived principal support and attendance at the training workshop predicted teachers' self-efficacy which in turn predicted high-level fidelity of implementation. In addition, teacher's attendance at the training workshop and their self-efficacy had a direct positive effect on fidelity of implementation. The Sobel test of mediation effect indicated that self-efficacy mediated the relationship between teachers' confidence, attitudes towards sex education, and perceived principal support and implementation fidelity ($z = 2.87$, $p = 0.004$; $z = 2.73$, $p = 0.006$; $z = 2.41$, $p = 0.016$).

Discussion

Our study adds to the growing implementation literature regarding effective teacher implementation support. This study developed and refined two theory-driven implementation strategies (BMF and SAM) which demonstrated significant effects on teachers' fidelity of implementation of an evidence-based HIV intervention in school setting. These strategies, consistent with the principles of community of practice (CoP) [25, 26], have evolved as part of the Bahamian school system's culture to support teachers who are

new in their position and to the program and those who have experienced challenges in implementation. These two implementation strategies developed by our team in collaboration with local teachers and school administrators are culturally appropriate. Our study also shows that teacher's full attendance at all training workshops and increased self-efficacy are directly related to increased fidelity of implementation. Teachers' confidence, attitudes towards sex education, and perceived principal support are significantly related to increased self-efficacy, which in turn is related to teachers' fidelity of implementation.

Our study identified several pre-implementation factors that are related to teachers' fidelity of implementation. Although teachers' attendance at the training workshop was not significantly associated with teachers' implementation, teachers' full attendance (completion of the training workshop) was related to increased fidelity of implementation. Full attendance of the training workshop may reflect teacher's high motivation and commitment to teaching the intervention curriculum. Teacher training workshops are critical for successful program implementation because they provide the background justification, knowledge, and skills needed to implement the program, increase teachers' self-efficacy, foster support and commitment to the program, and emphasize the importance of program fidelity [11, 14]. Likewise, teachers' previous implementation behavior (taught several sessions or some activities of FOYC in the past 12 months) predicted better performance in the following year. Teachers' sense of community ownership for the intervention was positively related to the fidelity of program implementation, which is consistent with prior research [43]. Our study found that teachers' comfort in teaching FOYC and CImPACT and leading roleplays were related to teachers' fidelity of implementation, which is consistent with findings from previous studies reporting teacher self-efficacy and comfort as significant predictors of implementation (adherence) [14]. Teachers' comfort level may reflect teachers' competencies and skills to deliver sensitive topics and to deal with difficulties encountered during the implementation. Our study revealed nonsignificant associations between teachers' perceptions regarding the importance of HIV prevention and implementation fidelity. The absence of an association may be due to the fact that vast majority of teachers perceived the importance of HIV prevention among youth (94% said it is very meaningful; 6% said it is somewhat meaningful).

Program delivery was a process consisting of several phases, including adoption, implementation, and continuation. Teachers needed support in every phase of the delivery process to enable them to effectively implement the program. Support in the implementation phase is crucial for optimal program effectiveness [30]. Our study indicates that pre-implementation teacher training was essential to equip teachers with necessary skills for implementation, but it is not enough. Biweekly implementation monitoring, personal assistance, and mentoring during program delivery were important to ensure teachers' quality of implementation. Implementation monitoring/assessment acts as a feedback mechanism to improve teachers' performance and ultimately improve program outcomes [23].

Several lessons were learned from this optimization study. First, the need to understand the importance and priority of the school's calendar of events cannot be understated. The priority of the Ministry of Education is focused on the events on the school calendar. Not taking this into account when planning research events is likely to negatively impact to research projects. Because district and national

examinations among grade six students (Grade Level Assessment Tests-GLAT) occur in the second term of the school year (Spring semester), the first term of the school year is the best time when FOYC + CImPACT can take place, with January, February and the first half of March for the last part of program implementation. Because our first-year grant was awarded three weeks before the commencement of the new school year, teacher training, identification and training of school coordinators and mentors, and preparation of program implementation took the important first term of school year. The optimization trial was conducted in the second term of school year when schools had other priorities (national examination), which had great impact on the implementation of the intervention curriculum. Second, selection and training of school coordinators are critically important. School coordinators who are more interested and/or enthusiastic about the program are more likely to encourage and monitor teachers' implementation. Third, school-based mentorship by experienced teachers provides great support to teachers who experience challenges implementing the curriculum. Mentors need to be identified early so that they can be trained to assist at-risk or moderate-performing teachers immediately following teachers' training. Fourth, transfers and promotions resulted in movement of teachers and school administrators which impacted the sustained implementation of FOYC at the sixth-grade level. There is a need for ongoing training during the school year (especially during summer and teacher professional development periods). Consideration should be given to electronic training (short video support and Webinars series) when face-to-face training is not accessible by some teachers in the more remote family islands.

There are several potential limitations in this study. First, this optimization study did not collect student outcome data, which prevented us from program outcome evaluation. This is because our study focused on teacher's implementation behavior and development of two theory-driven implementation strategies to enhance teachers' implementation. Thus, program outcome evaluation was beyond the scope of this study in Year 1 but can be incorporated in future studies. Second, the optimization trial only lasted for two months due to schools' priority of national examination among grade six students in the second term of school year. Third, our findings were based on teachers' self-reports of their extent of implementation of the FOYC + CImPACT intervention. It is possible that teachers over-reported their level of implementation. In the current study, trained observers independently observed and assessed approximately 20% of each teacher's classes. We found that the observer-teacher agreement was high (over 80%), indicating that teachers' self-reports of their implementation are reliable.

Conclusion

Our study adds to the sparse but emerging literature on the implementation of evidence-based interventions in school settings. Two theory-driven implementation strategies (BMF and SAM) are effective in promoting teachers' implementation of youth evidence-based interventions. Our study highlights the importance of selection and training of motivated school coordinators and mentors for successful program implementation. Several lessons learned may be useful for those involved in designing and/or implementing other teacher-delivered school-based health promotion programs. Two theory-driven, effective implementation strategies developed in our study can be used to promote the implementation of effective HIV prevention interventions in schools.

Declarations

Ethics approval and consent to participate

This study was approved by Univerisity of Massachusetts Medical School Institutional Review Board and the Institutional Review Board of the Bahamian Princess Margaret Hospital, Public Hospitals Authority. Participants provided formal written consent to participate in this study.

Consent for publication

Not applicable

Availability of data and materials

Data and materials are available for reviewers upon request

Competing Interests

The authors declare that they have no competing interests.

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Authors’ contributions

BW, BS, and LD conceived the research questions. BW and BS analyzed the data and drafted the manuscript. LC, XL, RF, SM, and NF helped in interpreting the data. RA, BD and VK were fully involved in data acquisition, data entry and validation. BW and BS obtained the funding of study. All authors were involved in the revision of the paper for intellectual content. All authors read and approved the final manuscript.

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Figures

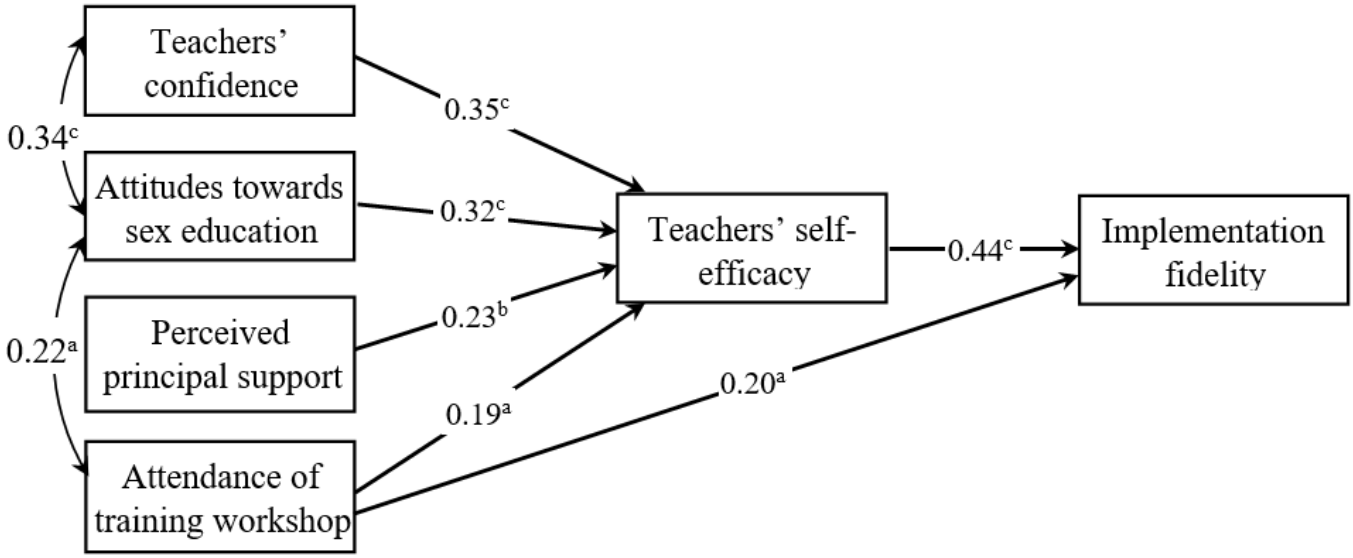

Figure 1

Revised structural model showing relationships among factors influencing teachers' fidelity of implementation. Standardized path coefficients are shown. Note: a $p<0.05$; b $p<0.01$; c $p<0.001$.