



Identifying Teacher Beliefs and Experiences Associated with Curriculum Implementation Fidelity in Early Childhood Education

Kelsey A. Clayback¹ · Amanda P. Williford¹ · Virginia E. Vitiello¹

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Abstract

Implementation science research points to the importance of improving implementation fidelity to improve outcomes and sustainability of interventions. Despite our growing understanding of factors related to implementation in K-12 settings, much less is known about factors influencing implementation in early childhood education contexts. Understanding factors related to how well early childhood educators implement an intervention is critical to developing ways to improve implementation fidelity and ultimately education quality. The current study explored how teacher beliefs and experiences were related to initial uptake and later implementation in a sample of 87 early childhood educators implementing a novel comprehensive curriculum, *STREAMin*³. Across teacher dosage, classroom dosage, and teacher responsiveness, teachers with more positive initial perceptions of the curriculum had higher implementation. Teacher stress and perception of center climate were inconsistently related to implementation. Public preschool teachers and teachers with fewer years of teaching experience also reported higher levels of implementation. Implications for supporting teachers to improve implementation fidelity are discussed.

Keywords Implementation · Early childhood · Preschool · Curriculum · Teacher beliefs · Teacher Stress

Evidence-based practices often fail to be successfully implemented in applied settings such as schools. This problem is referred to as the research to practice gap. Recently, the field of education has recognized the need to better understand this gap, including factors that influence how well practices and interventions are implemented in school settings. Implementation fidelity refers to the degree to which an intervention is implemented as intended (Elliott & Mihalic, 2004). In schools, interventions are most often implemented by educators, who face barriers such as a lack of resources and support, that may impede their ability to effectively implement evidence-based or novel practices (Forman et al., 2009; Han & Weiss, 2005). When practices and curricula are implemented, implementation fidelity varies widely within and across educational settings. Previous work has consistently demonstrated that positive outcomes increase when effective

interventions are implemented with higher fidelity (e.g., Hamre et al., 2010; Pas & Bradshaw, 2012).

To increase fidelity, we must thoroughly understand educator and school factors that influence implementation. Levels of implementation fidelity in K-12 settings are related to both organizational and individual variables, including teacher characteristics, attitudes, and school climate (e.g., Domitrovich et al., 2015; Han & Weiss, 2005; Ringwalt et al., 2003). Common barriers to implementation in schools include lack of resources, competing priorities, educator beliefs, and lack of support from school leadership (Forman et al., 2009; Kincaid et al., 2007). Relatively little is known about factors that influence levels of implementation fidelity among early childhood educators. Early childhood education, which includes infant, toddler, and preschool classrooms, is an important context in which teachers scaffold children through increasingly complex social, emotional, and cognitive experiences. As a result, interventions and policy in early childhood education settings have focused on improving education quality to foster positive early development. However, little is known about individual educator and school characteristics that may be related to how well these teachers implement new practices or curricula.

✉ Kelsey A. Clayback
kac5fd@virginia.edu

¹ Center for Advanced Study of Teaching and Learning,
University of Virginia, 405 Emmet Street South,
Charlottesville, VA 22904, USA

Understanding these factors is critical to developing ways to improve implementation fidelity and ultimately education quality. Malleable factors, such as educator beliefs and experiences, may be prime targets to improve implementation (Cook et al., 2015; Owens et al., 2014). The current study, thus, sought to explore factors related to early childhood educators' implementation of a novel comprehensive curriculum, *STREAMin*³.

Implementation Fidelity

Implementation fidelity is complex and multidimensional, including components such as dosage, adherence, and responsiveness (Dane & Schneider, 1998). Dosage refers to the quantity of intervention delivery, whereas adherence refers to the quality of delivery. Responsiveness refers to how implementers perceive the intervention, such as if they enjoyed it or if they perceived it as effective. Prevention researchers across fields have developed numerous frameworks for studying implementation fidelity (e.g., Feldstein & Glasgow, 2008; Keith et al., 2017). Domitrovich and colleagues (2008) proposed a three-level conceptual framework specifically for examining factors that influence implementation fidelity of school-based interventions. In this framework, the macro level refers to federal, state, and district policies that impact individual schools. The micro level includes factors related to the school and classroom setting include size, school climate, funding, and leadership. The individual level includes factors related to the teacher implementing the intervention, such as professional characteristics, psychological characteristics, and beliefs about the intervention itself. The framework has been used in previous implementation research in education settings, including work exploring predictors of implementation, and we used this framework to guide the current study. The current study focuses on micro- and individual-level factors influencing teachers' implementation (specifically teachers' dosage and responsiveness) of the *STREAMin*³ curriculum. Micro-level variables of interest include funding, classroom ages, and perception of school climate. Individual-level variables include background, role, stress, efficacy, and perception of the curriculum.

Predictors of Implementation Fidelity

Individual-Level Factors

Teachers, as implementers, ultimately decide whether and how well to deliver interventions (Han & Weiss, 2005). Some studies have found that less experienced teachers report higher implementation fidelity, though other background characteristics such as education are largely

unrelated to implementation (Domitrovich et al., 2015; Rohrbach et al., 1993). Teacher attitudes and beliefs, such as enthusiasm, self-efficacy, and beliefs about evidence-based practices, appear critical to successful implementation (Forman et al., 2009; McGoey et al., 2014; Rohrbach et al., 1993). Teachers with higher self-efficacy report a greater willingness to adopt new practices (Evers et al., 2002). Likewise, initial beliefs about new programs and practices are associated with higher implementation dosage over time (Cook et al., 2015; Domitrovich et al., 2019), as are teachers' perceptions of the new program's fit with their teaching style (Domitrovich et al., 2015).

Teacher distress may be another critical factor influencing a teacher's implementation. Stressed teachers report more barriers to implementing behavior interventions in their classrooms (McGoey et al., 2014). Teachers' burn-out is associated with lower dosage and adherence to a new curriculum (Domitrovich et al., 2015; Ransford et al., 2009), and may be particularly problematic when teachers also report low administrative support or low curriculum support, including coaching (Ransford et al., 2009). Further, evidence from a recent study found that a stress reduction program resulted in decreases in elementary teacher stress, which then resulted in increases in teacher reports of intervention fidelity (Larson et al., 2018). Taken together, previous work suggests that individual teacher factors, such as beliefs and experiences of stress, may be key proximal factors influencing implementation dosage. The current study, thus, considers early childhood teachers' initial beliefs, teaching efficacy, and stress as individual characteristics that may predict curriculum implementation over time.

Micro-Level Factors

Evidence also suggests that environmental characteristics, such as school climate and leadership support, are related to implementation fidelity in school settings. Teachers who report that their school has a more positive social-emotional learning (SEL) climate also report implementing an SEL intervention with higher adherence (Cook et al., 2015). In schools with a less positive climate, teachers may view a new intervention more negatively, and thus implement the intervention with lower fidelity (Beets et al., 2008). Alternatively, teachers who report higher levels of principal support exhibit higher implementation fidelity compared with teachers who perceived lower principal support (Gottfredson & Gottfredson, 2002; Rohrbach et al., 1993). The current study considers early childhood teachers' report of their center's climate as micro-level factors that may predict curriculum implementation over time.

Implementation in Early Childhood Education Settings

Several characteristics of ECE settings make these classrooms different than K-12 settings, warranting a separate exploration of implementation in these unique settings (Stipek et al., 2017). Early childhood education is provided through a variety of auspices, including public pre-kindergarten, Head Start/Early Head Start, private, and faith-based preschools. Each setting has different regulations, requirements, and resources (Bassok et al., 2020). Stress and turnover in early learning settings is high, with nearly a third of ECE teachers leaving the field each year (Wells, 2015). These differences and more result in early childhood educators having different training and professional development needs than K-12 teachers (Gomez et al., 2015). These teachers may have unique strengths and barriers when implementing new practices.

Three notable studies have explored predictors of implementation specifically in ECE. The first examined individual factors associated with instructional coach ratings of preschool teacher implementation in Head Start classrooms (Domitrovich et al., 2009). The second study investigated teacher implementation dosage of a school readiness curriculum among 49 Head Start and center-based childcare teachers (Baker et al., 2010). The third study examined teacher and program factors related to implementation of Banking Time, an intervention to improve teacher–child relationships with children who exhibit challenging behavior (Williford et al., 2015). All three studies found associations between teacher beliefs and implementation. Coach perceptions of teachers' openness to consultation were associated with adherence (Domitrovich et al., 2009), while teachers who had more concerns at the beginning of implementation had a lower dosage (Baker et al., 2010). Teachers who reported higher levels of burnout prior to implementation were rated by coaches as more effective implementers, though efficacy and depression were not related to implementation (Domitrovich et al., 2009). All three studies were limited in several ways that the current study addresses. For example, the first sample only included Head Start teachers, the second relied on teacher-report and only considered dosage, and the third did not examine teacher distress or center climate.

In sum, teacher beliefs and experiences may be malleable targets to improve intervention adoption, implementation, and eventual outcomes (Owens et al., 2014). The current study builds upon previous research by examining several teacher beliefs and experiences related to implementation fidelity reported by both teachers and their instructional coaches over time in a sample of early childhood educators implementing a new comprehensive curriculum.

*STREAMin*³ Curriculum Model

The *STREAM: Integrated, Intentional, Interactions* (*STREAMin*³; Williford et al., 2018, 2021) Curriculum model is a comprehensive, integrated curriculum package that focuses on the use of high-quality interactions (teacher–child and peer) to promote children's development of school readiness skills, including language, literacy, math, self-regulation, social-emotional, and motor skills. The curriculum includes classroom activities, routines, games, and formative assessments implemented by teachers in classrooms serving children from birth to five. The model embeds professional development and instructional coaching to support teachers' implementation. *STREAMin*³ follows practice-based coaching, centered around collaborative teacher-coach relationships to support teachers to use evidence-based practices in their classroom (Snyder et al., 2015). To implement this curriculum, teachers are tasked with adopting an entire curriculum package that affects all aspects of the classroom, rather than adopting a specific practice or targeted intervention. Teacher efficacy, stress, and center climate may be especially important in predicting teacher uptake of a completely new early childhood curriculum package, such as *STREAMin*³. This study, therefore, investigates how teacher beliefs, efficacy, stress, and center climate relate to initial and longitudinal implementation of *STREAMin*³.

Current Study

The current study addresses the following research questions: (1) How are teacher perceptions, efficacy, stress, and center climate related to initial implementation of a novel comprehensive curriculum? and 2) How are teacher perceptions, efficacy, stress, and center climate related to change in implementation fidelity, over and above initial fidelity? We hypothesized that teachers who report more positive initial perceptions and efficacy, less stress, and a more positive center climate will have higher implementation initially and over time.

Methods

Participants

Data were collected as part of a larger pilot evaluation study of *STREAMin*³ including teachers across Virginia (see Williford et al., 2021 for the evaluation report). Programs were initially recruited to participate in an evaluation study of the curriculum in spring 2019, and implementation data collection for the current study occurred during fall 2019 and spring 2020. Early

childhood program leaders were invited to a recruitment session to learn about the curriculum, materials, implementation supports, and evaluation and completed an interest form to indicate interest in participating. From the possible pool of programs that expressed interest, 37 programs (112 lead teachers) were invited to participate. These programs represented both public (state-funded and Head Start) and private programs and educators teaching a mix of infant, toddler, and preschool children, with preschool teachers purposely over-represented.

The current study included data from teachers who completed the intake survey, at least one fidelity survey, and the final survey at the end of the evaluation ($n = 87$ teachers, 34 programs; Table 1). On average, teachers had 14.72 years of ECE teaching experience ($SD = 8.85$, range = 1 to 37). Compared to the 25 lead teachers who did not complete all three of these components, the teachers in the current study had slightly more years of education (15.9 years vs. 14.4 years, $p < 0.001$) and were more likely to be teaching in a public setting ($p < 0.001$). Teachers in this sample did not differ significantly from the full sample in years of experience, gender, or race.

Coaching Procedure

Eleven highly qualified coaches were hired to support *STREAMin*³ implementation. Coaches participated in extensive training before and during coaching, including an online course, a one-day in-person workshop, a site visit to the school where the curriculum was developed and in use, and ongoing supervision from the research team. Coaches were assigned at the center level and had eight teachers on their caseload, on average. Coaches interacted with teachers and programs regularly through check-ins, meetings, observations, and professional development. Approximately every two weeks, the coach observed the classroom, focusing on a specific aspect of implementation. Coaches met with the teachers after for about 30 minutes to provide feedback and action plan.

Measures

Implementation Fidelity

*STREAMin*³ curriculum implementation fidelity data were collected across fall 2019 (time 1) and spring 2020 (time 2), prior to center closures due to COVID-19. Several aspects of implementation fidelity were measured, including teacher coaching attendance, classroom activity completion, and responsiveness to curriculum. Descriptive statistics for the implementation variables are reported in Table 1.

Teacher Attendance Teacher attendance (i.e., coaching dosage) included the total number of coaching sessions/monthly meetings that teachers attended, reported by coaches. Time 1

Table 1 Descriptive statistics ($n = 87$)

Demographic variables	%		
% Female	98.85	--	--
<i>Race</i>			
% White	65.12	--	--
% Black	30.23	--	--
% Other race	4.65		
<i>Level of education</i>			
% Lower than bachelor's degree	25.29	--	--
% Bachelor's degree	40.23	--	--
% Higher than bachelor's degree	34.48	--	--
<i>Classroom age level</i>			
% Infant classroom	10.34		
% Toddler classroom	13.79		
% Preschool classroom	75.86	--	--
<i>Center type</i>			
% Public	64.37	--	--
% Private-not faith affiliated	24.14	--	--
% Private-faith-based	11.49	--	--
Teacher beliefs and experiences variables	Mean	SD	Range
Initial perception of curriculum	5.95	2.49	0–10
Teacher stress	2.24	1.90	0–7.67
Teacher efficacy	8.42	1.30	4.27–10
Perception of center climate	8.49	1.57	3.97–10
Implementation variables	Mean	SD	Range
Attendance (T1)	5.59	2.57	0–14
Attendance (T2)	4.89	2.70	1–12
Activity completion (T1)	0.76	0.32	0–1.00
Activity completion (T2)	0.66	0.37	0–1.00
Responsiveness (T1)	5.87	2.70	0.07–9.89
Responsiveness (T2)	6.37	2.35	0–9.97

Teacher reported demographic, belief, and experience variables in Table 1 were collected at intake into the evaluation study (Spring 2019/Fall 2019). Other races and ethnicities included Asian (2.33%), Hispanic/Latinx (1.16%), and Multiracial (1.16%). Six Head Start teachers were in the sample and classified as “public” due to funding. T1 = time 1 (Fall 2019). T2 = time 2 (Spring 2020). Activity completion is proportion of days implemented in the classroom

teacher attendance included meetings from August 2019 to December 2019. Time 2 included meetings from January 2020 to March 2020, prior to center closures due to COVID-19.

Activity Completion Teachers completed two surveys reporting on how many days a week they used various *STREAMin*³ components in their classroom. The first fidelity survey (time 1) was completed in October 2019 during weeks 7 and 8 of implementation. The second fidelity survey (time 2) was completed in February 2020 during weeks 17 and 18 of implementation. The proportion of days that teachers reported implementing core skill supports was used as a classroom dosage outcome in analyses.

Responsiveness Teachers also completed a measure of their responsiveness to the curriculum in the fidelity survey 1 (time 1) and in the final study survey in March 2020 (time 2). This survey included eight items that teachers rated on a scale of 0 (strongly disagree) to 10 (strongly agree). Items included “*STREAMin*³ is helping me be a better teacher” and “Participating in *STREAMin*³ has been manageable for me this year.” Reliability in the current sample was good (time 1 Cronbach’s $\alpha = 0.94$; time 2 Cronbach’s $\alpha = 0.94$), and the average responsiveness score across items was used as an outcome in analyses.

Individual Teacher Beliefs

Teachers reported on their initial perception of the curriculum, efficacy, stress, and center climate through an intake survey at entry into the program (see Table 1).

Initial Perception Teachers reported on their initial perception of *STREAMin*³ using two items (“How much do you enjoy participating in the *STREAMin*³ pilot?” and “How likely are you to recommend the *STREAMin*³ curriculum to a colleague?”) at the beginning of their implementation. Teachers rated the curriculum on a scale of 0 (not at all) to 10 (very much), with higher scores indicating more positive initial impressions of the curriculum. The two items were highly correlated ($r = 0.92$, $p < 0.001$), and the average was used in analyses.

Teacher Efficacy Efficacy was measured using classroom management, instructional support, and student engagement subscales (Tschannen-Moran & Hoy, 2001). Teachers reported on 12 items using a 0 to 10 scale, with anchors at 0 (no influence), 5 (some influence), and 10 (a great deal of influence). Example items included “How much can you do to control disruptive behavior in the classroom?” and “To what extent can you provide an alternative explanation or example when children are confused?” Higher scores indicated a higher sense of efficacy. Reliability in the current sample was good ($\alpha = 0.94$). Analyses used average efficacy.

Stress Stress was measured using the Teacher Stress Inventory (TSI; Fimian & Fastenau, 1990). Teachers reported on 15 stress items using a 0 to 10 scale, with anchors at 0 (no stress), 5 (moderately noticeable stress), and 10 (extremely noticeable stress). Example items included “I feel frustrated because of discipline problems in my classroom” and “My class is too big”. Higher scores on the stress scale indicated more stress, and reliability in the current sample was good ($\alpha = 0.90$). Average stress was used in analyses.

Micro-Level Teacher Experiences

Teacher report of center climate was measured using three aspects of climate: professional teacher behavior (5 items; Hoy et al., 2002), collegial leadership (5 items; Hoy et al., 2002), and psychological safety (7 items; Edmondson, 1999). Teachers responded to 17 items on a 0 to 10 scale, with anchors at 0 (never), 5 (sometimes), and 10 (frequently). Example items included “Teachers provide strong social support for colleagues” (professional teacher behavior), “The director is friendly and approachable” (collegial leadership), and “Working with teachers at this center, my unique skills and talents are valued and utilized” (psychological safety). Higher scores indicated a more positive center climate, and reliability in this sample was acceptable (Cronbach’s $\alpha = 0.82$). Average center climate was used in analyses.

Additionally, we were interested in determining if implementation varied by other characteristics of the environment. In all models, we included center type, defined as center is public (reference group), private, or faith-based. Nearly 64% of the teachers were in publicly funded centers. We also included a variable indicating if the classroom age level was preschool (reference group), toddler, or infant to examine implementation by the classroom ages.

Data Preparation and Analytic Plan

All data preparation and analyses were conducted using STATA 16. Each implementation fidelity outcome variable was screened for normality using skew and kurtosis variables. Since attendance outcomes were count variables, we conducted Poisson regressions for those outcomes (Coxe et al., 2009). We used ordinary least squares regressions for the continuous outcomes (activity completion and responsiveness). For each model, standard errors were clustered to account for the nesting of teachers within programs (Cameron & Miller, 2015; Huang, 2016; Primo et al., 2007). This was necessary to account for the nonindependence of teachers within the same child care program. Based on previous literature, teacher years of experience was also included in all models (Domitrovich et al., 2015; Rohrbach et al., 1993). In models predicting implementation at time 2, we controlled for implementation at time 1.

Missing Data

In order to be included in the current study, teachers needed to have completed the intake survey, at least one fidelity survey, and the final survey. Teachers who completed these three components were included to ensure that our analytic sample was teachers who received the full curriculum

package, including coaching and professional development, across the year of evaluation. Teachers who were missing these data did not receive full training in the curriculum, because they either left their program or joined later, and differences in implementation fidelity are likely due to these teachers having less coaching and training opportunities. Among the 87 teachers in the current study, the majority of teachers (83.91%) were not missing any relevant data. Missing data on the outcome variables were as follows: 0% (meeting attendance), 2.29% (activity completion), and 19.54% (responsiveness). Little's CDM test comparing teachers with and without complete data indicated that missing at random (MAR) could be assumed, so we used multiple imputation using STATA's chained command to handle missing data.

Results

Correlations between implementation fidelity, individual characteristics, and micro-level characteristics are presented in Table 2. Implementation fidelity variables were significantly correlated across time, suggesting that implementation was somewhat stable. Dosage and responsiveness were overall significantly and moderately correlated with each other, suggesting that the variables were related but measuring distinct aspects of implementation fidelity.

Predicting Teacher Meeting Attendance

In predicting initial teacher attendance, initial perception was significant, and teaching efficacy was approaching significance ($p = 0.09$; Table 3). Teachers with more positive initial perceptions of *STREAMin*³ had significantly higher meeting attendance; a one-unit increase in a teacher's initial perception was related to a 0.13 increase in the number of full meetings attended in the fall, holding all other factors constant. Teachers with higher teaching efficacy also had higher meeting attendance. A one-unit increase in a teaching efficacy was related to a 0.14 increase in the number of full meetings attended in the fall, holding all other factors constant. Attendance significantly varied by classroom age; holding all other factors constant, meeting attendance was 1.84 times higher for toddler teachers compared to preschool teachers. Initial attendance was not significantly predicted by teaching experience, center type, stress, or center climate. Overall, the model accounted for 14.5% of the variance in initial teacher attendance.

In predicting teacher attendance in the spring, center climate approached significance ($p = 0.07$). Teachers who reported a more positive center climate attended more meetings in the spring; a one-unit increase in center climate was

associated with a 0.04 increase in spring meeting attendance. Attendance in the fall, teaching experience, and center type also emerged as significant. Teachers who attended more meetings in the fall tended to also attend more meetings in the spring; a one-unit increase in fall attendance was associated with a 0.05 increase in spring attendance, holding all other factors constant. Teachers with more experience attended significantly more meetings; a one-unit increase in years of teaching experience was associated with a 0.01 increase in spring attendance, holding all other factors constant. Teachers at private and faith-based centers attended significantly fewer meetings in the spring compared to teachers at public centers. Attendance was not significantly predicted by classroom age, perception, stress, or efficacy. The model accounted for 8.8% of the variance in spring attendance.

Predicting Classroom Activity Completion

In predicting initial activity completion, initial perception was significant, and center climate was marginally significant (Table 4). Teachers with more positive initial perceptions of *STREAMin*³ reported implementing significantly more curriculum activities. Teachers who reported a more positive center climate reported implementing less frequently. Teaching experience was also a significant predictor, and classroom age level was marginally significant. More experienced teachers reported implementing the curriculum less frequently, and toddler teachers reported implementing slightly more frequently than preschool teachers. Initial activity completion was not significantly predicted by center type, teacher stress, or teaching efficacy. Overall, the model accounted for 30.2% of the variance in initial activity completion.

In predicting activity completion over time, initial activity completion and teaching experience were significant, and center type was marginally significant. Teachers who reported implementing more activities in the fall tended to also implement more activities in the spring. Teachers with more teaching experience reported implementing the curriculum less frequently in the spring. Teachers in private centers reported implementing slightly fewer activities, compared to teachers in public centers. Classroom activity completion over time was not significantly predicted by classroom level, initial perception, stress, efficacy, or center climate. Overall, the model accounted for 33.1% of the variance in spring activity completion.

Predicting Responsiveness

In predicting initial responsiveness, initial perception was significant (Table 5). Teachers with more positive initial perceptions of the curriculum reported higher responsiveness.

Table 2 Correlations between implementation outcomes, teacher beliefs, and environmental characteristics

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. Attendance (T1)	--																
2. Attendance (T2)	.68***	--															
3. Activity completion (T1)	.14	.23*	--														
4. Activity completion (T2)	.19 [†]	.20 [†]	.43***	--													
5. Responsiveness (T1)	.26*	.34***	.58***	.48***	--												
6. Responsiveness (T2)	.29*	.35***	.59***	.43***	.85***	--											
7. Teacher experience	.13	-.04	-.25*	-.30**	-.28*	-.21 [†]	--										
8. Preschool classroom	-.09	-.15	-.28*	-.14	-.42***	-.33**	.18 [†]	--									
9. Toddler classroom	.12	.10	.21 [†]	.11	.30**	.21 [†]	-.22*	-.71***	--								
10. Infant classroom	-.00	.10	.15	.07	.25*	.22 [†]	-.01	-.60***	-.14	--							
11. Public center	.33*	.17 [†]	-.15	.04	-.26*	-.27*	.31**	.48***	-.33*	-.30**	--						
12. Private center	-.27*	-.13	.17	-.18 [†]	.17	.20 [†]	-.22*	-.37***	.24*	.25*	-.79***	--					
13. Faith-based center	-.14	-.09	-.01	.19 [†]	.16	.15	.17	-.22*	.17	.11	-.48***	-.20 [†]	--				
14. Initial perception	.20 [†]	.20 [†]	.36**	.16	.49***	.58***	-.01	-.18 [†]	.10	.14	-.18 [†]	.09	.16	--			
15. Teacher stress	-.13	-.01	-.27*	-.25*	-.35**	-.33**	.14	.15	-.13	-.07	.16	-.10	-.10	-.21 [†]	--		
16. Teacher efficacy	.11	-.03	-.01	.00	-.08	-.03	.10	.37***	-.17	-.32	.14	-.09	-.10	.09	-.27*	--	
17. Center climate	.27*	.04	-.08	.14	.04	.04	-.06	.13	-.00	-.19 [†]	.08	-.19 [†]	.13	.14	-.35**	.47***	--

T1 = time 1 (Fall 2019), T2 = time 2 (Spring 2020)

[†] $p \leq .1$; * $p < .05$; ** $p < .01$; *** $p < .001$

Table 3 Regression analyses predicting implementation teacher attendance (i.e., coaching dosage)

	Teacher meeting attendance (T1) ^a			Teacher meeting attendance (T2) ^b		
	IRR (SE)	<i>t</i>	<i>p</i>	IRR (SE)	<i>t</i>	<i>p</i>
<i>Individual-level factors</i>						
Time 1 attendance	--	--	--	1.05 (.02)*	2.77	.01
Teaching experience	.99 (.01)	-1.44	.15	1.01 (.00)*	2.23	.03
Initial perception	1.13 (.03)***	4.02	<.001	1.01 (.02)	.79	.43
Teacher stress	1.02 (.04)	.61	.54	.99 (.02)	-.57	.57
Teacher efficacy	1.14 (.09) †	1.66	.09	.98 (.03)	-.75	.45
<i>Micro-level factors</i>						
Center climate	1.07 (.08)	.82	.41	1.04 (.03) †	1.79	.07
Toddler classroom	1.85 (.44)*	2.57	.01	1.18 (.13)	1.44	.15
Infant classroom	1.05 (.41)	.12	.90	1.19 (.14)	1.46	.15
Private center	.78 (.19)	-.99	.32	.69 (.09)**	-2.81	.005
Faith-based center	.76 (.21)	-1.02	.31	.68 (.07)***	-3.77	<.001

Coefficients are reported in incident risk ratio (IRR) for ease of interpretation (George et al., 2020). Preschool was used as the reference group for classroom age, and public was used as the reference group for center setting. Standard errors were clustered by center/program and reported in parentheses. All variables were entered on one step

† $p \leq .1$; * $p < .05$; ** $p < .01$; *** $p < .001$

^aTotal model $F = 9.46$, $p < .001$, pseudo $R^2 = 0.145$

^bTotal model $F = 8.34$, $p < .001$, pseudo $R^2 = 0.088$

Teaching experience and classroom level also significantly predicted initial responsiveness. Teachers with more experience reported lower levels of initial responsiveness. Teachers in infant and toddler classrooms reported significantly higher initial responsiveness than preschool teachers. Initial responsiveness was not predicted by center type, teacher

stress, teacher efficacy, or center climate. Overall, the model accounted for 43.8% of the variance in initial responsiveness.

In predicting responsiveness over time, initial perception and stress were significant.

Teachers with more positive initial perceptions of the curriculum tended to increase their levels of responsiveness

Table 4 Regression analyses predicting implementation activity completion (i.e., classroom dosage)

	Classroom activity completion (T1) ^a			Classroom activity completion (T2) ^b		
	<i>B</i> (SE)	<i>t</i>	<i>p</i>	<i>B</i> (SE)	<i>t</i>	<i>p</i>
<i>Individual-level factors</i>						
Time 1 activity completion	--	--	--	.41 (.17)*	2.38	.02
Teaching experience	-.01 (.00)*	-2.32	.03	-.01 (.00)*	-2.24	.03
Initial perception	.05 (.02)**	2.88	.008	-.00 (.02)	-.02	.98
Teacher stress	-.03 (.02)	-1.13	.27	-.03 (.02)	-1.26	.22
Teacher efficacy	.02 (.04)	.52	.61	-.01 (.03)	-.34	.74
<i>Micro-level factors</i>						
Center climate	-.04 (.02)†	-1.97	.06	.02 (.04)	.49	.63
Toddler classroom	.17 (.09)†	1.91	.07	.04 (.09)	.48	.64
Infant classroom	.12 (.09)	1.31	.21	.11 (.13)	.88	.39
Private center	-.04 (.08)	-.47	.64	-.28 (.14)†	-1.95	.06
Faith-based center	-.15 (.13)	-1.17	.25	.05 (.11)	.44	.66

Standard errors were clustered by center/program and reported in parentheses. Preschool was used as the reference group for classroom age, and public was used as the reference group for center setting. All variables were entered on one step

† $p \leq .1$; * $p < .05$; ** $p < .01$; *** $p < .001$

^aTotal model $F = 2.56$, $p = .026$, $R^2 = .302$

^bTotal model $F = 6.89$, $p < .001$, $R^2 = .331$

Table 5 Regression analyses predicting implementation responsiveness

	Responsiveness (T1) ^a			Responsiveness (T2) ^b		
	B (SE)	t	p	B (SE)	t	p
<i>Individual-level factors</i>						
Time 1 responsiveness	--	--	--	.65 (.07)***	9.17	<.001
Teaching experience	-.07 (.02)**	-2.95	.006	.00 (.02)	.23	.82
Initial perception	.46 (.10)***	4.83	<.001	.24 (.06)***	4.38	<.001
Teacher stress	-.23 (.17)	-1.35	.19	-.19 (.08)*	-2.36	.03
Teacher efficacy	-.15 (.26)	-.59	.56	-.13 (.14)	-.92	.37
<i>Micro-level factors</i>						
Center climate	-.03 (.15)	-.18	.86	-.04 (.08)	-.46	.65
Toddler classroom	1.66 (.86) †	1.93	.06	-.49 (.33)	-1.49	.15
Infant classroom	1.78 (.69)*	2.58	.02	-.35 (.57)	-.62	.54
Private center	-.24 (.56)	-.43	.67	.60 (.27)*	2.19	.04
Faith-based center	-.13 (.71)	-.18	.86	.79 (.53)	1.50	.17

Standard errors were clustered by center/program and reported in parentheses. Preschool was used as the reference group for classroom age, and public was used as the reference group for center setting. All variables were entered on one step

^aTotal model $F = 8.43$, $p < .001$, $R^2 = .438$

^bTotal model $F = 20.44$, $p < .001$, $R^2 = .825$

over time. Teachers who reported lower levels of stress had increased levels of responsiveness over time. Responsiveness in the fall and center type also predicted responsiveness in the spring. Teachers with higher fall responsiveness and teachers at private centers had higher spring responsiveness, compared to public teachers. Responsiveness over time was not predicted by teaching experience, classroom level, teacher efficacy, or center climate. The model accounted for 82.5% of the variance in responsiveness over time.

Discussion

We explored teacher beliefs and experiences related to implementation of the *STREAMin*³ curriculum in early childhood classrooms. Previous research on teacher factors influencing implementation fidelity has focused on K-12 school settings, and less is known about different aspects of implementation fidelity in early childhood settings. We extended prior work by exploring how teacher beliefs and experiences are related to initial curriculum uptake and later implementation dosage and responsiveness in a sample of 87 early childhood educators.

Findings point to the importance of individual teacher beliefs and experiences in predicting implementation. Across teacher dosage, classroom dosage, and teacher responsiveness, teachers with more positive initial perceptions of the curriculum had higher implementation. This finding supports the importance of gaining teacher buy-in and commitment at the beginning of implementation. Previous work has similarly found that teacher beliefs about an intervention are

predictive of implementation fidelity. For example, elementary teachers with more positive initial beliefs demonstrate higher quality implementation, as measured by reported dosage over time (Domitrovich et al., 2019) and observed implementation (Cook et al., 2015). It is possible that teachers with more positive initial perceptions may have higher initial engagement with the curriculum, which in turn leads to sustained or increased positive perceptions and engagement. Future research is needed to understand how to best target teacher perceptions of new interventions, particularly at the beginning of implementation.

Other individual teacher experiences, namely, stress and perception of center climate, were inconsistently related to implementation. Teacher stress was only related to responsiveness; teachers who were less stressed at the beginning of implementation increased their responsiveness over time. Due to the new and comprehensive nature of the curriculum, *STREAMin*³ may have caused some teachers more stress, especially for teachers already experiencing high levels of stress at the beginning of implementation. This additional stress may have led teachers to view the curriculum more negatively over time. It is surprising that stress was not related to other implementation variables, given that teachers perceive stress as a serious barrier to implementation and stressed teachers report more barriers (McGoey et al., 2014). Further, teachers who reported a more positive center climate increased their attendance at coaching meetings (i.e., dosage) over time. It is possible that centers with more positive climates had leaders who were more engaged with *STREAMin*³ implementation and encouraged their teachers to attend meetings. Previous research has identified high

leader engagement and support as a facilitator of effective teacher implementation (Forman et al., 2009; Kincaid et al., 2007).

Teachers' sense of self-efficacy was not a significant predictor in any models. Previous research in early childhood has found similar results. For example, Domitrovich and colleagues (2009) found that self-efficacy did not predict coach ratings of preschool teacher adherence and quality of implementation in Head Start classrooms. However, it is notable that teachers themselves and intervention developers identify self-efficacy as an important component influencing ability to implement well (Forman et al., 2009; McGoey et al., 2014). Future research should further explore how teachers perceive connections between implementation and efficacy, and how coaching and other professional development can improve teachers' self-efficacy.

Teacher experience was a relatively consistent predictor of implementation. We found that teachers with more years of teaching experience implemented fewer classroom activities initially and over time and were less responsive to the curriculum initially. Previous work has similarly found that more experienced teachers implement with lower levels of fidelity (Domitrovich et al., 2015; Rohrbach et al., 1993). More experienced teachers may be more hesitant to try new practices, especially if they perceive that what they are currently doing in their classroom is working well for them and meeting the needs of their students. Implementation supports may need to use different approaches to more effectively engage teachers with varying levels of experience. Future work is needed to understand how we can support and encourage more experienced teachers in implementing new practices with fidelity.

Finally, implementation fidelity differences emerged over time based on whether the teacher taught in a public, private, or faith-based child care center. Teachers at public centers reported higher levels of implementation compared to private and faith-based teachers. Williford and colleagues (2015) similarly found that teachers at public centers had higher implementation dosage and quality, compared to Head Start and private preschool teachers. Public child care settings tend to have more resources than other early education settings, which may lead to public teachers being better able to implement new practices. Further, teachers in private child care settings have lower pay, lower levels of education, and higher stress and turnover, factors that undermine implementation fidelity (Bassok et al., 2020; U.S. Department of Education, 2016). Notably, our sample of teachers in private child care was small, and future research should explore implementation specifically in these settings. Teachers in child care settings may need higher levels of coaching and other support (e.g., additional teaching staff, materials, access to support staff) in order to improve implementation. Leaders and coaches should be aware of the unique needs

of teachers in their setting. Additional research is needed to understand and meet the needs of teachers across settings to support high-quality implementation and teaching.

Limitations and Future Research

This study was limited in several ways that warrant mention. First, the current sample was a small convenience sample and only included lead teachers. It is unclear if these results would generalize to assistant or co-teachers, or if teachers in these other roles may face different barriers or facilitators to their implementation. This represents an important area of future research, since much of early childhood education research focuses on lead teachers. Self-selection is also an issue in the current sample, as programs who chose to participate in this evaluation study may differ from programs who declined. Second, though we considered dosage and responsiveness, the current study did not include adherence. It is possible that teacher beliefs and experiences are particularly relevant in predicting a teacher's adherence, and future research should explore this. Third, we explored implementation fidelity in the context of the uptake of a new and comprehensive curriculum model, intended to replace existing curricula and be implemented at the program level. It is unclear if results would be similar for other interventions, especially at different stages of the implementation process or for interventions that focus on a specific practice or are implemented at the classroom/teacher level. More research is needed to understand implementation at various stages of implementation, including examining additional program-level and coach characteristics.

Conclusions and Implications

Findings from this study point to the importance of individual teacher beliefs and experiences in predicting implementation. In terms of practice implications, training and professional development should gain teacher interest and commitment from the very beginning of implementation. Additionally, leaders and intervention developers should involve teachers in the decision making around designing, selecting, and implementing an intervention or curricula to ensure teachers are on board. Leaders, coaches, and researchers should continue to work to understand and address why some teachers have lower levels of engagement and motivation, as it is critical to support every teacher to work towards high quality implementation.

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Declarations

Ethics Approval This study was performed in line with the principles of the Declaration of Helsinki. All procedures were approved by the Institutional Review Board at the University of Virginia.

Consent to Participate Program leaders consented for their program to participate in the evaluation study, and teachers voluntarily participated in surveys.

Conflict of Interest The authors declare no competing interests.

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