EVALUATION TECHNICAL ASSISTANCE BRIEF
for OAH & ACYF Teenage Pregnancy Prevention Grantees

October 2016 • Brief 12

Structural Elements of an Intervention

Program developers want to be able to accurately describe their interventions and understand which pieces of the intervention contribute to changes in participant outcomes. To do that, one first needs to define the structural elements of an intervention, or the critical/core components of a program, and then test whether those structural elements influence participant outcomes. Understanding which structural elements of an intervention are most influential for moving participant outcomes is important for two primary reasons: 1) documenting the core components of the intervention that are necessary to be implemented well, and 2) informing future adaptations of the intervention, by identifying which aspects of the program move participant outcomes the most (so that those elements are retained) and those that do not appear to contribute to attainment of outcomes (and, therefore, could be dropped or modified).

This brief provides guidance on unpacking interventions—specifically, it discusses how to dissect an intervention into its structural elements, measure aspects of implementation related to structural elements, and assess how receipt of structural elements relate to outcomes. At the early stages of an evaluation, it is critical to do the necessary planning for data collection of structural elements to allow for an empirical analysis of these data in the future. This brief presents steps to help researchers identify structural elements of the intervention, plan for data collection, and conduct exploratory descriptive analyses. We use a single example across all steps to help illustrate the general principles suggested at each step.

This is the first of two related briefs. The second brief will discuss more complex analytic approaches that support understanding how structural elements influence participant outcomes.

Step 1: Identify structural elements of the intervention

Structural elements are the active ingredients that make up an intervention (Abry et al. 2015). When describing the collection of intended "activities" to be implemented as a program, those individual pieces can be labeled as the structural elements of the program (W.K. Kellogg Foundation 2004). These ingredients are the parts of the intervention that are expected to change participant outcomes (Blase and Fixsen 2013; Shadish et al. 2002). Although all program models vary in the type and number of elements, typical structural elements for teen pregnancy prevention programs may include (but are not limited to):

- Classroom lessons of a curriculum
- One-on-one interactions with a health care provider
- Communication with parents
- Informational text messages
- Service learning projects
- Webpage or mobile application access

Action step. Create a list of all structural elements of the intervention made available to program participants. This detail may include intended frequency or length of each component, expected mode of delivery, or number of elements—this list therefore articulates the ingredients of the program as it is intended to be delivered. When identifying the structural elements of a program model, it is important to consider the level of detail for the list. This is especially true for programs that contain many types of structural elements. For example, if your intervention is multifaceted, made up of 12 classroom lessons and other structural elements listed above, you might consider "classroom lessons" as a single structural element. However, if your intervention is more focused and made up of two one-on-one interactions with a counselor, it may be appropriate to consider each interaction as its own structural element. These decisions should be driven by theory and experience; however to keep things manageable for data collection and analysis, we recommend limiting the number of structural elements to broad categories (typically including no more than five elements).

To examine the structural elements of an intervention, you won't need data from a comparison group. The analysis can be performed using only data from the treatment condition.

Example intervention with three structural elements

- **Classroom lessons:** 10 sexual health lessons conducted during health class (2x/week for 5 weeks)
- **Text messaging:** 5 text messages delivered weekly focused on safe sex practices (5 messages total)
- **Service learning:** 4-hour service learning project completed during one weekend

Step 2: Identify intervention implementation conditions associated with each structural element

After creating a list of the structural elements for a program, you will need to identify the mechanisms through which the program is offered to participants, and how those participants ultimately receive these elements. If the structural elements are *what* make up a program, intervention implementation conditions define *how* the structural elements reach participants. For the purposes of this brief, we are primarily concerned with how structural elements are received by participants, as the critical features of implementation to track (rather than the amount of a program that is "offered")—and therefore, we are taking a relatively narrow view of intervention implementation conditions as a specific type of implementation "output" (W.K. Kellogg Foundation 2004). That is, these intervention implementation conditions help convey how much of the intended program participants received.

Program participants access structural elements through conditions including, but not limited to (1) attending program sessions, (2) receiving effectively communicated/delivered program content, and (3) actively engaging with program materials. By identifying the intervention implementation conditions, you will be able to better understand the mechanisms by which participants receive structural elements as intended. In addition, you will more thoroughly understand the potential barriers that may impede program participants to effectively receive the intended structural elements. Critically, to understand how structural elements influence outcomes, carefully unpacking these implementation conditions (and measuring them, as described in a subsequent step) provides an opportunity to more accurately assess the amount of an element received and how well participants received it.

Action step: To identify the implementation conditions, create a list of the necessary features of implementation that serve as avenues or impediments for getting structural elements to participants. That is, list the necessary conditions or means/mechanisms through which participants can receive the structural elements. It may be useful to put these implementation conditions into operation with actual concrete data points (which we explore further in step 5). Examples of intervention implementation conditions and how they can be defined include (but are not limited to) the following:

- **Dosage.** Number of sessions attended, length of stay on a website, number of activities completed on a mobile application, number of text messages received
- **Engagement.** Ratings of youth engagement from facilitator fidelity logs, ratings of engagement from observation forms
- **Quality of delivery.** Ratings of interaction quality from observation forms, quality ratings from participant feedback forms
- **Adherence to intended delivery.** Mode of delivery, qualifications and characteristics of facilitator

For additional examples, see the box in Step 3.

Step 3: Create a matrix of structural elements and implementation conditions

When developing the list of implementation conditions, it may be necessary for a combination of conditions to work together for a participant to effectively receive a given structural element. For example, for a typical structural element like classroom instruction to be effectively received, youth need to (1) attend sessions, (2) be engaged, and (3) have material delivered in a high quality manner. The interactive nature of the intervention implementation conditions can be used to put into operation a more nuanced matrix representing the connections between structural elements and intervention implementation conditions. On the other hand, a text messaging structural element might require only sufficient dosage and engagement of the youth for the material to be effectively received; quality of the delivery of the text might be unnecessary to consider because all texts are delivered in an identical manner.

Thinking carefully about the combinations of structural elements and implementation conditions can set the stage for a comprehensive reporting of program implementation – that is, how the program was implemented and ultimately received by participants in a process evaluation. Planning for and reporting on features of implementation is a key feature of the Getting to Outcomes approach for implementing and evaluating programs (Wiseman et al., 2007).

Action step: From the structural elements identified in step 1 and the implementation conditions identified in step 2, create a matrix representing these data points. The rows of the matrix should be the structural elements of the intervention, and the columns should be the intervention implementation conditions. The cells of the matrix can include the example data points described previously. Note that some cells in the matrix might not seem to be critical or have a point of data that seems logical (for example, the quality of the delivery of text messages). And in the example shown on the following page, we have opted to only consider three implementation conditions (we have excluded adherence to simplify presentation).

Example matrix of structural elements and intervention implementation conditions

Structural elements	Implementation conditions		
	Dosage	Engagement	Quality of delivery
Lessons	Number of lessons attended	Number of students engaged during a classroom observation	Quality of instruction received
Texting	Number of text messages received	Number of responses to text message queries	n.a.
Service learning	Number of hours attended	Level of youth engagement	Alignment of the service learning project with youth interest

n.a. = not applicable.

Step 4: Develop a causal pathway diagram that links structural elements to outcomes

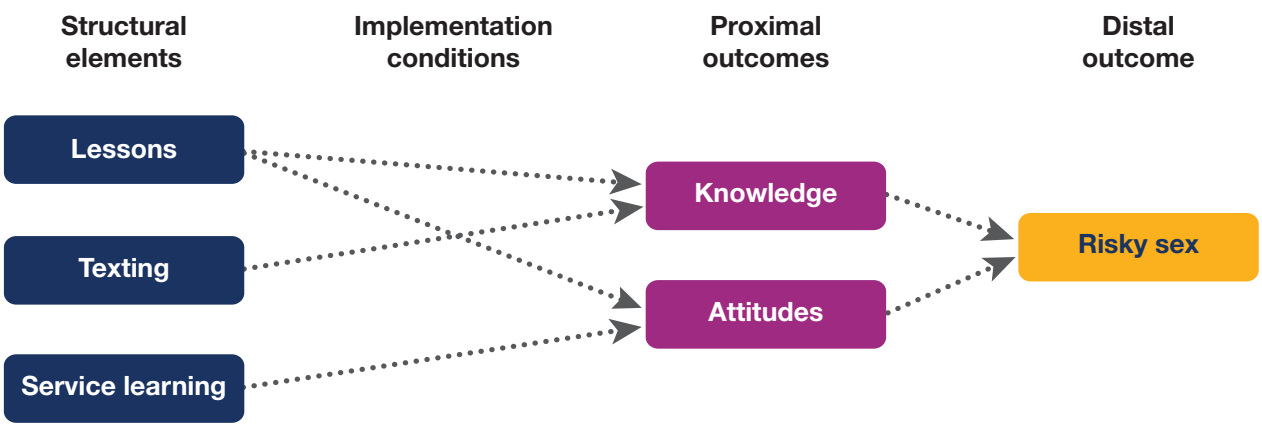
Developing the list of structural elements and intervention implementation conditions is the first phase in understanding how an intervention can influence outcomes. However, not every structural element of an intervention is expected to play a role in influencing every participant outcome. To provide a framework for how structural elements influence participant outcomes, we recommend developing a causal pathway diagram (occasionally labeled as a logic model) for the particular study. You should base this causal pathway diagram on how elements of the intervention are assumed to affect outcomes – this exercise will provide insight into how analyses will be conducted in subsequent steps.

In many cases, there may be intermediary variables between the structural elements and the outcomes of interest. You might consider that the target behavioral outcomes of interest are distal, or long-term, outcomes and more proximal, or short-term, outcomes are affected as precursors, or mediators. The proximal outcomes may include knowledge, attitudes, and intentions thought to have an effect on the distal outcomes (such as sexual onset, use of condoms, or other risky sexual behaviors).

Action step: To document your hypotheses for how the structural elements affect outcomes, develop a list of proximal and distal outcomes for each structural element. Then draft a causal pathway diagram, using arrows to show the connection from the structural elements to each outcome. The implementation conditions represent the arrows between structural elements and proximal outcomes; therefore, the proximal outcome can be influenced only when the implementation conditions facilitate the flow of information about the structural element.

It's possible that not all structural elements influence the same proximal outcomes. For example, your causal pathway diagram may assume that the classroom lessons influence both proximal outcomes of attitudes and knowledge, but that texting might influence only one outcome (knowledge) and that service learning might influence only the other outcome (attitudes).

Example showing the hypothesized causal pathway from the structural elements to proximal outcomes and a distal behavioral outcome



Step 5: Measure cells in the matrix and outcomes in the causal pathway diagram

To assess which structural elements predict outcomes, you need data for each cell in the matrix developed in step 3 and for each outcome listed in step 4. This data collection allows for a variety of analyses (described in step 6) to better understand how structural elements influence the intended outcomes.

Action step: To the extent possible, collect data on each participant, for every cell in the structural element and implementation condition matrix. Participant-level data might include, for example, the dosage received for each structural element or whether each participant received high quality delivery of a particular structural element. You may obtain these data through administrative records, observations of programming, surveys, etc. Data should be at the participant level, therefore, group-level ratings (such as of teacher implementation quality) may need to be applied as a common/constant score to each participant in a given class. (Note—it is possible to only use group-level data, rather than individual level data—however, in subsequent sections, analyses will effectively be comparing groups of participants, rather than individual participants. And therefore, interpretation of such results will need to be more careful and nuanced.)

It may be difficult to collect high quality data on certain data elements. For example, although detailed attendance data might be available for many structural elements, data on aspects of quality may be challenging, or even infeasible, to collect. Such situations may produce limitations in the types and credibility of the subsequent analyses that can be conducted.

Beyond collecting data on the intersection of structural elements and implementation conditions, you will also need to collect participant-level data for proximal and distal outcomes. The most likely data source for these types of outcomes is from follow-up surveys. Understanding how these proximal and distal outcomes vary across participants will allow you to explore whether there are features of implementation that potentially influence these outcomes.

When possible, we recommend not only assessing the proximal and distal outcomes at follow-up surveys, but also collecting baseline measures of these variables. By collecting baseline measures of these proximal and distal outcomes, you can examine how participant outcomes change, potentially as a function of variability in exposure to structural elements of the intervention. And these baseline measures can be used to add rigor to the types of analyses that examine the relative effectiveness of individual structural elements as influencing participant outcomes.

Step 6: Conduct analyses

At this phase, you have collected data on intervention implementation conditions for the structural elements of the intervention, as well as data on proximal and distal outcomes of interest. Therefore, you could conduct analyses to describe features of implementation and link structural elements to outcomes, to understand which parts of a program are most likely to influence outcomes.

In this section, we provide some basic ideas for describing these two data sources, and making some basic comparisons to understand how structural elements influence participant outcomes. These analyses can serve as the foundation for more advanced and complex methods of conducting these analyses (to be described in a subsequent brief).

Action steps. To put the analytic approach into operation, we propose substeps, described next. First, we propose to create rules for defining categories of the intervention implementation conditions for each structural element of the intervention. Next, we describe how to use these rules to generate individual-level categorical variables for analysis. Finally, we suggest comparing proximal and distal outcomes by these categorical assessments of the intervention conditions.

1. **Create rules for categorizing each cell in the matrix.** In step 3, we identified types of data in a cell for a given structural element and implementation condition. For example, the number of lessons attended could represent dosage for a classroom lesson structural element, and a count of engaged students during a classroom observation could represent the level of engagement. Typically, these data are count or continuous measures (for example, number or percentage of sessions attended, average quality score on an observation instrument), and analysis can be simplified by categorizing these measures. Occasionally, there may be simple rules for this categorization scheme that the program developer or the research community have generated (for example, one must attend 75 percent of sessions to be considered as having an adequate dose of a program, or a score on an instrument of 4 or above represents high quality instruction). Other times, it may be necessary to assess histograms or box plots to create meaningful categorizations of the data; for example, a histogram may illustrate a clear threshold (or multiple thresholds) of scores for a given variable. By creating or identifying rules for categorizing intervention implementation conditions for a given structural element, it is possible to put individuals into buckets of "high" and "low" for a given data point, which can simplify analysis. The box on the next page provides an example.

Example rules for categorizing intervention implementation conditions for the classroom lesson structural element

- **Dosage:** Assume the model developer considers 75 percent attendance sufficiently high dosage of the model. Therefore, the rule for this variable could be:
  - If attendance is greater than or equal to 75 percent, then High_Dosage = 1. Else High_Dosage = 0.
- **Engagement:** Assume the model developer provides no formal rule about the expectations for engagement. However, in reviewing a histogram of the engagement data (number of students engaged in a class), it appears that having five students being engaged is a tipping point: there is one hump of data for classes where fewer than five students are engaged, and similarly, a second hump of classes where more than five students are engaged (and the humps represent substantively different counts of engaged students). Therefore, the rule for this variable could be:
  - If at least five students in the class are engaged, then High_Engagement = 1. Else High_Engagement = 0.
- **Quality:** Assume again, the developer provides no formal rule about the expectations for quality.

  Again, an examination of a histogram of quality of teaching illustrates two humps in the data, where scores above 3 on a 5-point observation form of teaching quality help differentiate the two groups. Therefore, the following rule could be used:
  - If average quality score is greater than 3, then High_Quality = 1. Else High_Quality = 0.

2. **Calculate categorical assessments for each participant-level record.** Given the rules created above, it is possible to create scores that place each participant-level record into a "bucket," or "category," for a given variable, as shown in the example below. For example, it is possible to state whether each person received a high dose of a given structural element. You can apply these rules to the available data using any statistical package to create additional variables for analytic purposes. Beyond creating categorical assessments for each intervention implementation condition, and examining their direct effects on outcomes, you can also calculate combined assessments of implementation across the implementation conditions, to understand the pooled and potentially interactive nature of these elements. That is, for a given structural element (for example, classroom lessons) to have been delivered as intended, a person must (1) receive a high dose of an element, (2) demonstrate high levels of engagement, and (3) receive high quality implementation. Therefore, these indicator variables can allow researchers to examine whether individual aspects of implementation, or the combination of all aspects of implementation play a role in participant outcomes.

Example data for three intervention implementation conditions for the classroom lesson structural element

In the table below, we have taken raw data (the shaded cells) from the implementation of an intervention and used the rules listed in the previous example to create new categorical versions of these data. We created columns for the three new variables and appended them to the right of the raw, shaded columns. In addition to the variables corresponding to the rules listed in the previous example box, we created a new variable:

All_Conditions—takes on a value of 1 when all three implementation intervention conditions were high, as was the case with ID4. This variable is critical when a researcher believes that all of the implementation conditions are critical for a participant to effectively receive a structural element.

ID	Dosage (percentage attended)	Engagement (number of students engaged in a class)	Quality (quality scale [1-5 Likert scale])	High_ Dosage	High_ Engagement	High_ Quality	All_ Conditions
1	90%	2	2.5	1	0	0	0
2	50%	2	2.5	0	0	0	0
3	70%	8	4	0	1	1	0
4	80%	8	4	1	1	1	1

This process has created categorical variables that can be used to compare different types of individuals—for example, comparing those who had a high dose (High_Dosage = 1) of an element against those with a low dose of the intervention (High_Dosage = 0) or comparing those who have experienced high levels on all three aspects of implementation (All_Conditions = 1) against those who did not have high levels any of the conditions (All_Conditions = 0).

3. **Compare proximal and distal outcomes against these newly created indicators of implementation.** Given the measures of the proximal and distal outcomes for each observation, it is possible to make comparisons across different groupings of individuals (see the example below). Using simple descriptive methods, you can answer such questions as, "Do individuals with high levels of attendance of classroom lectures have better knowledge scores than individuals with low levels of attendance?" or "Do individuals with high levels of engagement in the service learning structural element have better attitude scores than individuals who were not engaged?" Similarly, questions can be expanded to examine distal outcomes of interest or other versions of the implementation conditions—for example, "Do individuals who received high dosage, engagement, and quality scores for classroom lectures have better behavioral outcomes than individuals who did not have high levels of dosage, quality and engagement?" Answering these questions might help provide direction for revisions of the program model. For example, if there are large differences in outcomes based on dosage levels in classroom sessions, this would suggest that classroom sessions are potentially a critical component of the program for changing participant outcomes. On the other hand, if the analysis shows that there is no difference in proximal or distal outcomes among those who differ in their exposure to a structural element (for example, text messaging), this might indicate that the text messaging structural element is less critical for effective programming. By conducting a variety of descriptive analyses, you can identify some avenues for future hypothesis testing under a more rigorous evaluation design and provide insight into potential enhancements/revisions to an existing program.

Example outcome data related to indicators of implementation for the classroom lesson structural element

The table shows the comparison of the proximal and distal outcomes against the indicators of implementation for the classroom lesson structural element. We examine two different groupings of youth on all three outcomes in the causal pathway diagram, given that classroom lessons are intended to affect all outcomes:

- Groups defined by levels of classroom lesson dosage (high vs. low dosage)
- Groups defined by levels of implementation across all conditions for classroom lessons (individuals with high levels of dosage, engagement and quality vs. individuals who had at least one implementation condition that was low)

	High_Dosage = 1 Mean or percentage (standard deviation)	High_Dosage = 0 Mean or percentage (standard deviation)	Mean difference (p-value of difference)	All_Conditions = 1 Mean or percentage (standard deviation)	All_Conditions = 0 Mean or percentage (standard deviation)	Mean difference (p-value of difference)
Knowledge score (out of 100)	87.5 (4.3)	60.6 (3.2)	26.9 (<.001)	88.2 (3.3)	57.6 (2.2)	30.6 (<.001)
Attitudes score (out of 100)	81.2 (8.2)	80.8 (5.6)	0.4 (.34)	82.4 (4.1)	81.0 (4.6)	1.4 (.11)
Risky sex (percentage yes)	15.9	16.1	-0.2 (.18)	14.6	17.2	-2.6 (.04)

Youth who received a high dose of classroom lectures (High_Dosage = 1) had higher knowledge scores but similar attitude scores, and they engaged in as much risky sex as those with lower dosage (High_Dosage = 0). This provides some preliminary evidence that suggests that higher levels of classroom attendance may influence participant knowledge but not necessarily attitudes or behaviors—at least not over and above any effects obtained by the low attenders.

In addition, youth who experienced high levels of dosage, engagement, and quality of classroom lessons (All_Conditions = 1) had higher knowledge scores and were less likely to engage in risky sex than youth who did not experience these conditions of implementation (All_Conditions = 0). These results suggest that not only is it important for youth to attend the classes, but being engaged and taught with high quality improves distal outcomes, such as risky sex in this example. In addition, this result also highlights that optimal implementation of the classroom lessons does not appear to appreciably improve participant attitudes—and thus, the causal pathway diagram could be revised to remove the pathway from classroom lessons to participant attitudes (but maintaining the link to knowledge and the subsequent link to the risky sex behavioral outcome).

Conclusion

In summary, careful documentation of structural elements of interventions and collection of data on implementation of those structural elements can provide researchers and practitioners with valuable insight into how programs work. Beyond having the ability to more carefully describe aspects of a program and how they were implemented, it is possible to use these data to inform programmatic technical assistance. Using these data may help practitioners recognize which aspects of a program are the drivers of participant outcomes and, thus, the ones that should be emphasized and enhanced. Similarly, such analyses can also uncover the aspects of a program that could theoretically be reduced, modified, or eliminated, if they are not influencing the expected changes in participant proximal or distal outcomes.

Note that the types of analyses described here are limited and rely on nonrigorous approaches to examining these relationships. For example, a key limitation of the analyses shown here is the lurking selection internal validity threat. We have compared groups of individuals who differ in terms of their implementation experiences on outcomes of interest – however, it may have been the case that these groups defined by implementation experiences may have looked dissimilar on baseline assessments of the outcomes of interest (or on other variables expected to influence outcomes). As such, the observed differences in outcomes associated with differences in implementation may have an alternative explanation.

References

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This brief was written by Russell Cole and Lauren Murphy from Mathematica Policy Research for the HHS Office of Adolescent Health under contract #HHSP233201300416G.