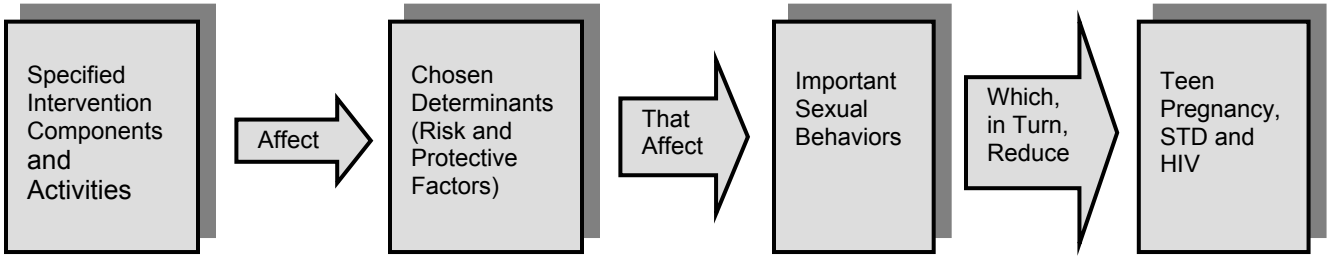
BDI LOGIC MODELS:

A Useful Tool for Designing, Strengthening and Evaluating Programs to Reduce Adolescent Sexual Risk-Taking, Pregnancy, HIV and Other STDs



by

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Finally, I wish to acknowledge my sociology professors at UCLA who trained me in causal modeling, which provided one of the theoretical bases for BDI logic models.

Availability of On-Line Interactive Course

ETR has developed an interactive course on how to develop BDI logic models. It is based on this paper, but is designed as a beginner's course and greatly simplifies some of the material in this paper. It also provides templates and other resources that can be used to create BDI logic models.

The course is available free of charge and can be accessed at:
http://www.etr.org/recappreview/logicmodelcourse/.

It can also be purchased from ETR on a CD ROM. For more information, please call Pat Rex at 831 438-4060, ext 106.

"Would you tell me, please, which way I ought to go from here?"
"That depends a good deal on where you want to get to," said the Cat.
"I don't much care where --" said Alice.
"Then it doesn't much matter which way you go," said the Cat.
"--- so long as I get somewhere," Alice added as an explanation.
"Oh, you're sure to do that," said the Cat, "if only you walk long enough."

From *Alice's Adventures in Wonderland* by Lewis Carroll

Alice in Wonderland did not know where she wanted to go or how to get there. Far too often people in our own communities may not be entirely clear about the health goals they wish to achieve and/or do not have clear and effective directions for how to achieve their health goals. BDI logic models help people identify where they want to go (what health goal they wish to achieve in their community) and then help them create a clear, effective and strategic map for getting there.

Introduction

When a community is faced with a particular health problem, such as teenage pregnancy, sexually transmitted disease, substance abuse, poor nutrition, insufficient exercise or violence, that community can implement promising programs or initiatives to address that health problem. Both the process of creating BDI logic models and the logic models themselves can help communities design and implement large comprehensive initiatives as well as specific programs or components within those initiatives. BDI logic models can also improve the evaluation of community programs and initiatives.

What are logic models, specifically BDI logic models?

Figure 1 provides an example of a logic model for a community initiative to reduce unintended teenage pregnancy. It specifies that the community will implement sex education programs in schools and youth serving agencies (including churches), sports programs for girls, mentoring programs for all youth, and parent programs to help them monitor their teenage children more effectively and to discourage their school-aged children from going steady with other older youth. The model also specifies the particular determinants that each component is designed to change and that previous research has demonstrated have an impact on sexual behaviors. Finally, it specifies the particular sexual behaviors that will be affected by changes in these determinants and that will in turn reduce teen pregnancy.

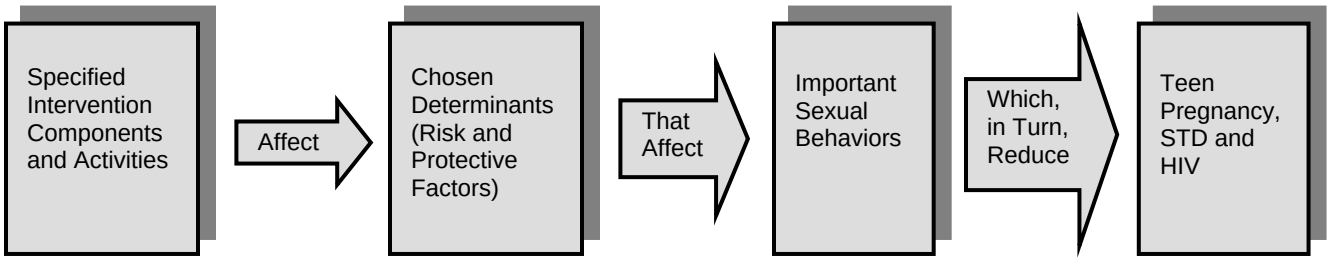
Figure 2 provides an example of a more detailed logic model for a particular component in the broader initiative. A more detailed logic model could (and often should) be created for each of the components in a larger initiative. Figure 2 provides a possible logic model for church-based

abstinence-only programs. Like the model in Figure 1, this model specifies particular activities that will be implemented, the determinants that the activities will improve and that in turn will increase abstinence, and finally the goal of reducing teen pregnancy.

As both of these examples illustrate, logic models are graphic depictions that show clearly and concisely the causal mechanisms through which specific interventions can affect behavior and thereby achieve a health goal. One might think of them as road maps specifying the causal pathways between programs and behaviors. Like road maps, logic models should be based upon the best available data and evidence. Otherwise, they may provide poor or misleading directions. Logic models can also portray the "theories of change" that people sometimes develop for interventions. Occasionally, logic models are called causal models or path models.[1]

While there are many types of logic models, some logic models include a specification of 1) the health goal to be achieved, 2) the *behaviors* that need to be changed to achieve a health goal, 3) the *determinants* (i.e., the risk or protective factors) of each of those behaviors, and 4) the *intervention* components or activities designed to change each selected determinant. Henceforth, this paper will refer to these particular logic models as behavior-determinant-intervention logic models, or "BDI models" for short. BDI models must also include the causal linkages among the health goal, the behaviors affecting that goal, their determinants, and their respective intervention components. That is, they specify which particular intervention components affect which determinants that, in turn, affect which behaviors that achieve the health goal.

These components of a BDI logic model can be depicted graphically as follows:



Although this depiction has grouped intervention components, determinants, behaviors and health outcomes into each of their respective boxes, in fact, actual BDI logic models must specify separately the interventions designed to affect each of the determinants, the determinants that affect each of the behaviors, etc. This is illustrated in the figures at the end of this paper.[2]

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[1] For readers familiar with logframe models, logic models are similar to, but different from, logframe models. Logframe models typically do not identify the determinants of behavior (as do BDI logic models), but do identify the steps for implementing a program. When developing a logframe model, it would be useful to develop a BDI logic model first.

[2] This paper is designed especially for those who are interested in reducing teen pregnancy or STD rates, and this focus is reflected in the figures at the end of the paper. However, some readers of this paper may be interested in using BDI models to help achieve other health goals, and accordingly, in the text of this paper, examples involving other health goals are also provided.

While many logic models include these four components, they sometimes use different words to describe them. Some may use the language of "interventions," "determinants," "behaviors," and "health goals," while others may refer to "activities," "short-term objectives" and "long-term outcomes," or "processes," "outcomes," and "impacts" respectively.

There are also other variations among these BDI models. Some include only these four minimum components, while others may specify far more complex causal models, with some determinants of behavior affecting other determinants, with reciprocal causality acknowledged (e.g., determinants affecting behaviors *and* vice versa) and with some models nested within other models (examples are discussed later in this paper). Some BDI models may target youth while others target adults or people of any age. Some models describe individuals while others describe groups, communities, institutions or entire countries. In fact, BDI logic models can even be used effectively to change the behavior of other species. In general, they are useful whenever one needs to change individual or group animal behavior in order to achieve some desired outcome. Some BDI models may summarize the impact of large multi-component programmatic initiatives upon major goals (e.g., the model in Figure 1), while others describe in much greater detail the impact of specific activities upon particular behaviors (e.g., the example in Figure 2). BDI models are sufficiently flexible and robust to handle all these situations. However, by definition, BDI models must include some version of the same basic concepts, and must specify the causal linkages among intervention components, the mediating determinants, the behaviors that lead to a health goal, and, of course, the health goal.

How can BDI logic models be useful to you?

BDI models can serve a variety of useful functions. In general, they provide a framework for the development of more effective programs and for the evaluation of those programs. More specifically, if developed properly and used properly, BDI models can:

- Link key intervention components and activities to key determinants of important behaviors, the behaviors themselves, and health goals.
- Make explicit the implicit theories behind programs and thereby provide a clear rationale for program activities, a rationale that will facilitate funding and provide guidance to program staff or to different organizations involved in the initiative.
- Encourage program designers *and* program implementers to not only recognize the complexity of reality, but also to focus on the most important program elements, determinants and behaviors.
- Encourage evidence-based programming.
- Help determine what additional information needs to be gathered or what research needs to be conducted in order to design or improve a program.
- Guide both the design of a program and the refinement of an existing program.[3]

[3] Logic models can be a particularly useful tool when using participatory learning and action research strategies for bringing different groups in a community together to design new interventions that address the needs of youth. They can summarize in an organized manner some of the thoughts expressed by different groups.

- Provide guidance to evaluators on which process and outcome indicators to measure.
- Reduce unreasonable pressure to demonstrate impact upon a health goal, if effects upon important determinants or health behaviors are demonstrated.
- Help health educators and researchers realize that they may not know which determinants are the most important determinants of behavior, and thereby stimulate appropriate research to identify the most important determinants.
- Help integrate program design and program research, and facilitate cooperation between program designers and researchers.
- Provide the foundation for the cumulative building of theory and understanding of what works and why it works.
- And ultimately, help programs serve people more effectively and efficiently and thereby improve the use of limited resources and more effectively achieve health goals.

When should you create BDI logic models?

When designing a larger initiative to achieve a health goal, it is almost always useful to complete the process of developing a logic model and to then use the logic model to inform participants in the initiative about how their activities are part of a larger initiative.

When selecting or designing a particular program or component in a larger initiative, it is often, but not always, productive to create a logic model. Sometimes the single most promising strategy for selecting or designing a program does not involve creating a logic model and developing a new program, but instead involves implementing one or more programs that have already been developed and demonstrated to have a desired impact among a population similar to the community's target population. For example, to reduce teen pregnancy or teen STD rates, a community might implement with fidelity specific sex or HIV education curricula that have been demonstrated to be effective with similar teenagers. When effective programs already exist, then it is less important to develop BDI logic models. On the other hand, BDI logic models can still be used to help evaluate the impact of the program (if such as evaluation is being conducted) or to refine the program.

Other times, programs demonstrated to be effective with similar populations may not exist, required resources may not be available, community values may be inconsistent with those of the effective programs, or the community may have other needs or goals that bear upon the problem. When this is the case, then new programs must be designed and BDI logic models can be a very useful tool to help develop those new programs.

The Assumptions that Underlie BDI Logic Models and Their Development

BDI logic models, like all models, are based upon a set of assumptions. In this case, there are three assumptions underlying the models themselves, and four assumptions underlying the recommended *process* for creating the models.

Assumptions underlying BDI models

1. ***Behaviors of individuals, groups, and institutions largely determine health goals.*** For example, individuals' frequency of sex, number of sexual partners, and use of condoms and clinics' testing and treatment for STD substantially affect STD transmission. Some behaviors have a greater impact upon achieving a health goal than do other behaviors and some are more amenable to change than others.

2. ***A variety of determinants (i.e., risk and protective factors or other influences) have an impact on these behaviors.*** For example, use of alcohol prior to sex, motivation to avoid STD, attitudes towards condoms, and availability of condoms may affect individuals' use of condoms. Typically, these determinants fall into different domains. That is, they may describe characteristics of individuals and their peers, partners, families, schools, health services, community institutions, other community characteristics, and government policies. Some of these determinants have a greater impact upon behavior than do others, and some of them are more amenable to change than others.

3. ***Because of individuals' freedom, typically interventions designed to achieve a health goal cannot directly control individual, group, or institutional behaviors, but they can affect those determinants that in turn affect important behaviors.*** For example, interventions cannot directly control individual sexual or condom behavior, but properly designed interventions can affect use of alcohol prior to sex, motivation to avoid STD, attitudes about condoms and availability of condoms, and thereby affect sexual and condom behavior. Some of these interventions have a greater impact upon determinants than do others, and some of them are more easily implemented given available resources than are others.

Assumptions involving the recommended process for creating the model

1. ***If the goal of a model is to achieve a health goal, then that model is more likely to be effective if a logical process is used in which first the goal is selected, then the behaviors affecting that goal, then the determinants affecting those behaviors, and finally the interventions affecting those determinants.*** The importance of this assumption may not be entirely self-evident. When addressing a health problem (e.g., teen pregnancy or STD), some health practitioners consider those problems and then begin focusing directly on program activities without first identifying all the important behaviors to be changed and all

the determinants affecting those behaviors. These practitioners believe that their knowledge of "best practices" from previous experience will produce the desired outcomes (Green & Kreuter, 1999). Although knowledge of best practices should always inform the development of interventions and logic models, simply identifying best practices to achieve a health goal without first specifying clearly the behaviors and determinants of those behaviors is often not the most effective process for designing interventions to achieve a health goal. Instead, it is commonly more effective to create a BDI model — to specify the health goal and to then focus attention first on the behaviors to be changed, then the determinants of those behaviors, and finally the interventions needed to change those determinants. This process increases the chances that the intervention components will have the desired behavioral impact and will achieve the health goal (Green & Kreuter, 1999).

2. ***The final model is more likely to be effective if it first recognizes the complexity of reality by identifying the wide variety of behaviors, determinants, and interventions in different domains that may ultimately affect a health goal.*** Typically reality is complex and there commonly exist multiple behaviors that affect a health goal, and multiple determinants that affect each of those behaviors. If this complexity is not recognized, then potentially important determinants or behaviors may be ignored, and programs and initiatives will be less effective than they can be.

3. ***The final model is more likely to be effective if people focus upon those behaviors, determinants and intervention components that are both 1) the most important in terms of having the greatest impact and 2) are most amenable to change or implementation.*** By focusing upon those that have the greatest impact and are most amenable change, the models and their proposed interventions become both strategic and feasible.

4. ***The final model is more likely to be effective if the best available evidence is used to determine which behaviors and determinants are most important and most amenable to change and which kinds of interventions have the greatest impact upon the selected determinants.*** Basing the model and subsequent programs upon the best available evidence increases chances of success and also makes them more strategic. This does not mean that the evidence must be perfect before creating a logic model, but it does mean that stronger evidence will produce a more effective model, and where evidence is weak, stronger evidence should be obtained, if feasible.

This paper now more fully describes the process for actually creating BDI logic models and provides examples of them.

Important Elements and Steps in Creating BDI Logic Models

Creating BDI models means creating causal models. It is a tradition in social science research models to have the direction of causality proceed from left to right, and that tradition is often maintained in logic models, including BDI models. Thus, because intervention activities affect behavioral determinants that, in turn, affect behaviors that affect one or more health goals, intervention activities are written on the left and health goals on the right. Consequently, when BDI logic models are completed, people can read them from left to right as they normally do. However, given that health goals must be specified first and intervention activities last, when creating BDI models, people must start on the right and work left, a process that may feel counterintuitive.[4]

Creating a logic model involves completing four basic steps:

1. Identify possible health goals and select the health goal(s) to be achieved,

2. Identify potentially important behaviors that affect the selected health goal, and then select the particular behaviors to be targeted,

3. Identify potentially important determinants of the selected behaviors and select those determinants to be targeted, and

4. Identify possible interventions and then select the particular intervention components or activities that have sufficient strength to improve each selected determinant.

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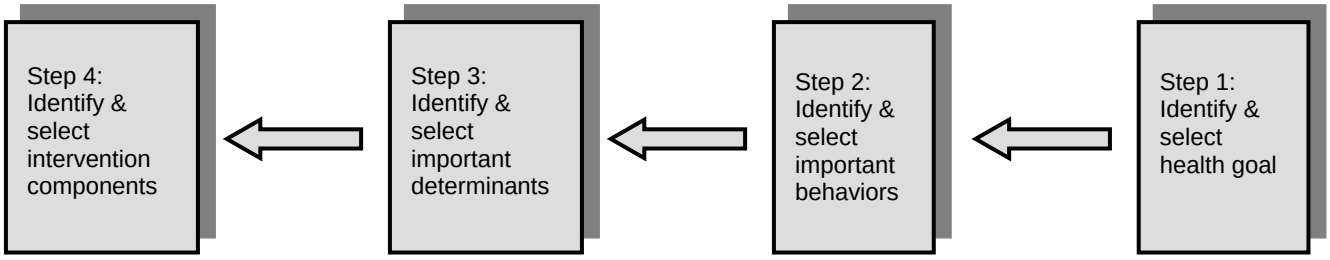
[4] Aside from convention, there is no reason why the direction of causality cannot be the opposite direction (from right to left), in which case people would start on the left with the behaviors and work to the right. This paper, however, follows convention.

Logic models can be classified as either "backwards" logic models or "forward" logic models according to the direction in which they are created. (Thus, these labels do not have any pejorative connotations.) Backwards logic models are called "backwards" because they involve starting at the right with the health goal followed by the behaviors and working "backwards" to the left. Forward logic models are called "forward" models because they involve starting with the program, thinking about all the program's consequences and working progressively to the right.

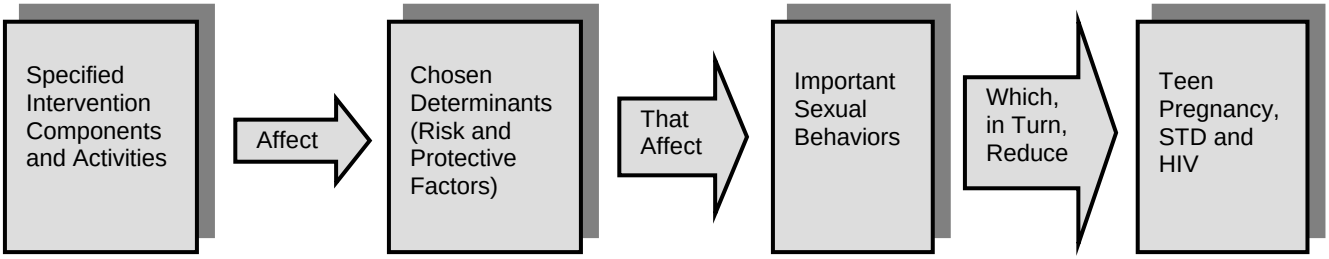
Whether one works backwards or forward may have a dramatic impact upon the model. Nevertheless, both backwards and forwards logic models can be useful. If a group's goal is to achieve a particular health goal, then it should start with that health goal and work backwards to the left. If a group's goal is to justify an existing program by demonstrating how it will affect multiple behaviors and goals, then it should start with the program and work forwards to the right. Sometimes when groups are trying to explain how a particular program will achieve a particular health goal, they may work both left and right while developing a model.

Thus, a BDI logic model is created from right to left, as depicted in the upper row of boxes and arrows below. However, the completed model is read from left to right as is customary and as depicted in the lower row of boxes and arrows below.

Steps for completing the logic model:



Completed logic model:



Notice that within each of these four basic steps for creating a logic model, there are typically two generic sub-steps or tasks, namely, 1) *identifying* the broader range of possible health goals, behaviors, determinants and intervention activities, as the case may be, and 2) *selecting* the specific health goals, behaviors, determinants, and intervention activities that will form part of the logic model. All of this is described more fully below.

Step #1: Identify possible health goals and select the health goal(s) to be achieved.

Often, people developing health promotion interventions have one or more clear health goals in mind (e.g., reducing teen pregnancy, reducing teen STD, reducing teen substance abuse, improving nutrition, increasing exercise, reducing violence or reducing air pollution). When this is the case, they may merely need to write this goal down.

However, if the important health goal(s) are not clear, or if there is a lack of consensus about which goals should be targeted, then the people designing the interventions and creating the BDI model may need to identify a broader range of health goals and then select one or more goals that will be the focus of the logic model and ultimately the interventions.

To help identify a broader range of health goals and select a specific one, people may need to collect data on what health problems most diminish quality of life, what problems are currently being addressed, and what resources are available, and then reach consensus on the important health goal(s) to be targeted.

Answering the following questions may help identify the goal(s) and population(s) to be targeted:

- What are the key health and development issues facing different target populations?
- How severe or critical is each of them? That is, how positive or negative are the consequences among those affected?
- How prevalent or widespread is each of them?
- What is the mandate of your organization?
- Given reasonable resources at your disposal, which health goals can you affect?

When specifying the health goal, the target population should also be specified, e.g., "reducing the teen pregnancy rate among teenagers in a specific community." Being specific is important, because what is specified in the steps below may vary with the population being targeted. For example, the determinants of unintended pregnancy among youth planning to go to college may differ from those among youth who have dropped out of high school. The target population may be identified by its health behaviors or by other characteristics such as, age, sex, ethnicity, income level, or area of residence.

Step #2: Identify potentially important behaviors that affect the selected health goal and then select the particular behaviors to be targeted.

After selecting a health goal, it is important to identify all the important behaviors that directly affect that health goal and to then select some (or all) of these behaviors to ultimately address.

When identifying and selecting behaviors, it may be helpful to answer the following questions:

- What are the behaviors that directly cause or affect a health goal?
- Which have the greatest causal impact upon the health goal?
- Which are the most frequent or prevalent?
- Given reasonable resources at your disposal, which behaviors can you change the most?
- Are there other factors that should affect the decision about which behaviors to target? If so, what are they?

If the overall goal of a project is to decrease teen pregnancy, then "reducing the frequency of sex" (through delaying sex and reducing the frequency of sex among those who have sex) and increasing use of contraception are the important behaviors leading to that goal (see Figure 3). If the overall goal of a project is to decrease teen sexually transmitted disease, then reducing the frequency of sex (again through delaying sex and reducing the frequency of sex among sexually experienced teens), reducing the number of sexual partners (both by delaying sex and reducing the number of partners among sexually experienced teens), increasing the correct and consistent use of condoms, and increasing tests and treatment for STD are important behaviors leading to that goal. If an overall goal is to reduce the prevalence of smoking, then there are three behaviors that can lead to this goal: reducing the number of people who begin to smoke, reducing the frequency of smoking among those who do smoke, and increasing the number who stop smoking.

It is important that the behaviors selected either *directly affect* the health goal or *are actual components* of the health goal. For example, as shown in Figure 3, the initiation of sex, the frequency of sex, and the use of contraception all directly affect pregnancy. Eating at least three meals a day, consuming a sufficient number of calories, eating sufficient amounts of fruits and vegetables, etc. are all components of the goal of improving nutrition. Similarly, engaging in aerobic exercises at least 30 minutes three times per week, completing specific weight lifting exercises, and engaging in specific stretching exercises may all be important components of a goal of improving exercise. Thus, all of these behaviors should be specified.

In contrast, although alcohol and drug use are indirectly related to pregnancy, they do not *directly* cause pregnancy. Rather, they may affect initiation of sex, frequency of sex and/or use of contraception, which, in turn, affect pregnancy. Thus, drug and alcohol use should not be included among the behaviors that directly cause pregnancy, but instead should be included among the determinants of initiation of sex, frequency of sex, and use of contraception. (Determinants are discussed further below.)

When creating BDI logic models, it should be remembered that some important behaviors may have a positive impact upon the health goal and others may have a negative impact. Both should be considered. For example, early initiation of sex may increase the chances of unintended pregnancy while using contraception may decrease the chances.

In general, important behaviors may also involve individuals (e.g., teens engaging in sex or using contraception and thereby affecting pregnancy), groups (e.g., whole families engaging in activities and thereby increasing attachment), institutions (e.g., companies engaging in specific manufacturing processes and thereby affecting air pollution), or governments (e.g., governments providing specific health services and thereby affecting specific health goals).

It is very important to identify rather precisely the specific behavior(s) that must be changed to achieve a health goal. "Delaying the onset of intercourse" and "increasing use of condoms" are sufficiently precise, while "decreasing unprotected sex" may be insufficiently precise because there are multiple ways to reduce unprotected sex — by delaying sex, reducing the frequency of sex, and increasing condom or contraceptive use — and each may involve different determinants, different interventions, and even different institutions. Similarly, "reducing the initiation of smoking" or "increasing smoking cessation" are sufficiently precise, whereas "reducing smoking" may not be sufficiently precise because there are multiple ways to achieve this goal, and preventing people from beginning to smoke may require different interventions than helping people to stop smoking.

As these examples suggest, sometimes the precise and important behaviors that affect an overall goal can be logically identified or are already known from research. If they are known, then, of course, they should be used in the creation of BDI models.

However, sometimes the most important behaviors for a particular goal have not been identified or the *relative* impact of specific behaviors upon a selected goal may not always be known. For example, if the goal is to reduce adolescent STD/HIV, the relative impact of delaying sex, reducing the frequency of sex, reducing the number of sexual partners, reducing the number of casual partners, increasing the use of condoms, or increasing testing and treatment for existing STDs

might not be known for a particular target population. Thus, additional research is sometimes needed to more fully inform even the selection of important behaviors.

Because of the time and resources required to complete such research, and also because of the common urgency to begin developing effective programs before definitive research is completed, people developing programs sometimes have to make an educated guess as to which behaviors are the most important and should be addressed by programs. While program designers create interventions based upon assumptions about the most important behaviors, researchers should conduct the necessary research to confirm which behaviors, indeed, are the most important in achieving a particular health goal.

When deciding which behaviors should ultimately be targeted by programs, the potential ability of a program to change each behavior should also be recognized. Many behaviors can often be targeted effectively by programs, but sometimes some behaviors cannot be. For example, obtaining testing and treatment for STDs is very important in preventing the transmission of STD, but in some very poor communities in developing countries, STD services are simply not available and cannot be provided by a program.

When selecting behaviors on which to focus, sometimes additional criteria must affect the choice. When additional criteria must affect choice of behaviors, these criteria should be reflected in this step of the development of the logic model. For example, the values of a community may dictate that programs focus only upon delaying sex rather than upon both delaying sex and increasing contraceptive use. If this is the case, then only delaying sex would be kept in the model and would be the focus of the steps that follow below.

Step #3: Identify potentially important determinants of the selected behaviors and then select those determinants to be targeted.

Given the specific behaviors to be changed, the important determinants of *each* of those behaviors need to be identified. After most important determinants have been identified, specific ones meeting certain criteria should be selected.

"Determinants" are the factors that affect whether or not individuals, groups, or institutions engage in specified behaviors. That is, the determinants of behavior have some causal impact upon behavior.

However, stating that determinants affect behaviors does *not* mean that specific determinants affect behavior in every individual situation in a mechanistic way. For example, research has demonstrated that teens' personal values about premarital sex or their values about teens their age having sex do affect whether or not they engage in sex. Thus, their values *partially* determine their sexual behaviors. However, other factors also affect whether they have sex. If they are very much in love, they may have sex anyway, or if they drink too much, then their values may cease to limit their behavior. Thus, in this paper, "determinants" refer to factors that generally influence behavior or partially determine that behavior, but do not necessarily fully determine behavior.

Possible determinants should include both risk factors and protective factors. For example, in terms of engaging in sex at an early age, risk factors might include community poverty, divorced parents, permissive values about sex, and older romantic partners, while protective factors might include community opportunity, attachment to family, attachment to school, plans to attend college, and conservative values about sex.

Sometimes people focus upon only risk factors and ignore important protective factors. They may thereby inadvertently paint an excessively negative picture of the population being targeted and may ignore protective factors that could be strengthened to help people avoid risk behavior. Conversely, given the current popular emphasis upon protective factors, sometimes people may focus only on protective factors and ignore important risk factors. Doing this can also reduce program effectiveness. When designing programs, it is often productive both to enhance strengths and to address weaknesses.

Initially, at least, it is important to identify determinants in different domains, e.g., characteristics of the individuals targeted as well as characteristics of their environments, including their peers, families, schools, communities more generally, and government policies.

Thus, when identifying potentially important determinants, it may be helpful to answer the following questions:

- What are the risk and protective factors in different domains that most strongly affect each behavior?
- What is the evidence for each of these factors? That is, is there good research demonstrating that each factor has a substantial influence upon the selected behavior for the targeted population?

Furthermore, given that important determinants often lie in different domains, experience suggests that it is important to involve people from these different domains when identifying potentially important determinants (e.g., parents, school teachers, and clinic staff). Often people working in different domains will have different perspectives on which possible determinants may, in fact, be important.

Figure 4 presents a comprehensive model of probable determinants[5] affecting behaviors specified to reduce teen pregnancy in Figure 3. This means that it includes lists of risk and protective factors that affect their associated sexual behaviors. Figure 4 is divided into multiple pages simply for ease of presentation. However, it is actually a single model. It is also just an example. It is a model of probable determinants in one just one country — the United States. Other countries and specific communities within the United States undoubtedly have additional or different determinants. However, all of these determinants have been identified by one or more research studies (Kirby, 2001). Some of these determinants undoubtedly have a much greater impact upon the sexual behaviors than do other determinants.

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[5] All of the "probable determinants" identified in Figure 4 have been demonstrated to be correlated with their respective sexual behaviors and they logically precede those behaviors. Thus, they probably, but not necessarily, affect those behaviors.

As depicted in Figure 4, teen pregnancy can be reduced by delaying the onset of sex, reducing the frequency of sex, or increasing the use of contraception. In turn, each of these three behaviors are affected by a large number of environmental and individual factors, including factors describing the individuals' community, family, peers and partner, as well as factors describing the individuals themselves, and the individuals relationships to these entities. These determinants also include both risk factors and protective factors. For example, initiation of sex is affected by community education, employment and poverty; family structure, education, income, religiosity, and sexual values; peer attitudes about sex and sexual behavior; the individual's closeness to his/her family; attachment and success in school; romantic relationship; use of drugs and alcohol; other deviant behaviors; previous sexual abuse; and sexual beliefs, skills to avoid sex, and intention to have sex; among others.

It should be noted that although Figure 4 may resemble a BDI logic model, that causal model is not yet a BDI logic model, for it does not yet specify the particular determinants that will be targeted by the intervention nor does it specify the particular interventions that will be implemented. Creating a comprehensive causal model, like the one in Figure 4 with its lengthy lists of risk and protective factors in different domains, sometimes forces the program designers to recognize the complexity of the situation and the wide range of possible determinants to focus upon. Acknowledging this complexity and range of possibilities can sometimes contribute to community consensus because people with different views can see their beliefs reflected in the comprehensive model. It may also encourage program designers to think more broadly and to consider approaches different from those they initially expected to employ.

Realistically, it is never possible to adequately address all the determinants in a complex causal model with interventions sufficiently powerful to modify each determinant substantially. For example, it is not possible to address all the determinants in Figure 4. Thus, program designers must select particular determinants to focus upon.

Two criteria should determine which determinants should be selected: 1) the magnitude of the causal impact of the determinant upon the specified behaviors, and 2) the potential magnitude of the causal impact that a feasible intervention can have upon the selected determinant. As noted above in the assumptions, some determinants have a greater impact upon behavior than others have. For example, under some conditions, both increased mother/daughter communication about teen sexual behavior (protective factor) and going steady with someone three or more years older (risk factor) affect the chances of a teen female having sex. However, often having an older boyfriend has a greater impact than does greater mother/daughter communication. This would suggest that the intervention should focus more upon helping girls avoid having older boyfriends than upon increasing mother/daughter communication. However, this decision reflects only the first criterion and not the second. Under some conditions, it may be much easier for programs to increase mother/daughter communication about sexuality than to persuade girls not to have older boyfriends. Thus, the second criterion must also be given equal consideration.

In general, if a feasible intervention can have a large impact upon a particular determinant, and if that determinant, in turn, has a large impact upon a specified behavior, then that determinant should be selected, and in Step #4 below it should be targeted by the proposed intervention. On the other hand, if any feasible intervention cannot substantially change a possible determinant, *or* if the

determinant does not have a significant impact upon behavior, then targeting that determinant is not likely to be an effective use of resources. That is, *both* criteria above must be met; otherwise, there is no point in selecting and ultimately targeting that particular determinant.

Determinants can be selected from any of the domains specified in Figure 2. That is, they can be individual, peer, partner, family, school, or community determinants. Of course, the domains from which determinants are selected have important implications for the interventions to address them. For example, if determinants are selected from the individual domain, then interventions can work directly with teens; if determinants are selected from the family domain, then the interventions need to work with parents and families; if community determinants are selected, then the intervention needs to work with the appropriate individuals or groups in the community.

When selecting specific determinants, answering the following questions will be helpful:

- Which determinants are most strongly related to each behavior?
- What is the strength of the evidence for each of them?
- Which determinants can be most markedly changed by feasible interventions?
- What is the strength of the evidence for this impact? That is, is there good research demonstrating that feasible intervention can markedly change the determinant?

When answering the questions above, groups sometimes focus upon the third question first because they are more accustomed to thinking about the risk and protective factors that their existing programs address than they are to thinking about how to address new risk and protective factors that have a strong impact upon behavior. Consequently, it may be useful to think first about which determinants have the greatest impact and then to think about innovative ways to address them. However, in the final analysis, both criteria should be given approximately equal weight.

In Figures 5 and 6 are examples of determinants selected from Figure 2 and used in the BDI models discussed more fully below.

To the maximum extent feasible, the identification of the important determinants should be based upon both theory and research. *Emerging Answers* (Kirby, 2001) includes a very extensive review of research on the determinants for different sexual and contraceptive behaviors. It identifies hundreds of risk and protective factors and suggests which may be the most important in general. Other summaries of research in other fields have identified important risk and protective factors for other health behaviors.

Of the probable determinants identified in *Emerging Answers*, the most important ones are included in Figure 4. Of those identified in Figure 4, many of the sexual beliefs, attitudes, skills and behaviors are among the determinants that are most strongly related to their respective sexual behaviors.

Ideally, of course, the identified risk and protective factors would be based upon research conducted on the actual target population to be served by the intervention. Often it is possible to find research on similar populations, but rarely is it possible to find research on the actual group being targeted.

Relatively inexpensive and quick methods of identifying some determinants of behavior among a particular target population include conducting interviews or focus groups with the target population and interviews with key informants and asking both groups why some youth do engage in sexual risk-taking and why others do not. Asking both types of questions elicits both risk and protective factors.

Although inexpensive and relatively quick, such methods often do not elicit many of the factors that shape behavior, but are not recognized by the individuals involved. For example, teenagers, like adults, are not likely to think of the many ways their families or media have shaped their values and thus their behaviors during their life times.

A more rigorous method of identifying the important determinants involves: 1) identifying appropriate behavioral theories and research summaries of determinants to help decide what should be measured, 2) using qualitative methods to further inform what should be measured, 3) developing measures of the possible determinants, 4) conducting surveys, 5) statistically analyzing the relationships between possible determinants and actual behavior, 6) observing which determinants are most important, and 7) finally using qualitative methods to further interpret the results.

This need to know which determinants most strongly affect selected behaviors can then provide the basis for the research agenda for subsequent research to be conducted by other researchers.

Step #4: Identify possible interventions and then select the particular intervention components or activities that have sufficient strength to improve each selected determinant.

Once the important determinants are selected, then specific programmatic components or activities with sufficient efficacy to actually change these determinants must be identified, developed and implemented. Because few determinants are easy to change, typically multiple components or activities need to target each determinant. However, more important than the number of components or activities is the efficacy of each component or activity. That is, one very effective activity may be more important than several relatively ineffective activities. In addition, programs or activities that are not targeted specifically to particular determinants are less likely to have as much impact upon those determinants.

Important questions to answer are:

- Which interventions (policies, programs, or program activities) can have the greatest impact upon each of the selected determinants?
- Are these interventions (policies, programs, or program activities) sufficiently powerful that they will actually markedly change each selected determinant?
- What is the evidence for this?
- Are the proposed policies, programs and activities feasible? More specifically, are the proposed policies, programs, and activities culturally feasible, given the values and social and cultural context of the community? Are they politically feasible given the existing power structure and

interests of relevant groups? Are they administratively feasible, given the existing structure of relevant organizations? Are they technically feasible, given the staff capabilities and program resources? Are they financially feasible, given reasonable estimates of costs and likely financial resources?

Commonly it is useful to create a matrix in which each column represents a single selected determinant and each row represents a policy, program component, or activity. An "X" can be placed in each cell in which a program component affects the determinant. It is then easy to scan down each column and see which activities affect each determinant and to assess whether or not those program components are sufficient to markedly change the determinant.

The amount of detail that is needed when describing program components or activities may depend upon the purpose of the logic model. If the purpose is to provide an overview and to demonstrate how different program components will address various determinants and behaviors, then the logic model might summarize each component succinctly and illustrate the behaviors that these components address. This was done in Figure 1. However, if the purpose is to actually design an effective program, then the activities must be described in much greater detail as in Figures 2 and 5.

What do BDI logic models actually look like?

Given the determinants identified in Figure 4, many different logic models are plausible, and different ones might be most effective in different communities or cultures. Following are examples illustrating different approaches that program designers might take.

Example of a school curriculum-based logic model focusing upon individual psychosocial determinants. Figure 5 is an example of a logic model for a comprehensive school-based pregnancy prevention intervention that focuses upon individual psychosocial determinants in order to delay sex, decrease sexual activity and increase contraceptive use. It includes all of the behaviors in Figure 4, and some, but not all, of the individual determinants in Figure 4. And, of course, it specifies the particular curriculum activities or programmatic elements that will affect the selected determinants.

It specifies, for example, that the teacher will lead group discussions in which students discuss the advantages and disadvantages of engaging in sex but will emphasize the advantages of abstaining. In addition, the class will discuss methods of showing you care for someone without engaging in sexual behavior. These activities may decrease permissive attitudes about premarital sex and increase favorable attitudes toward abstinence. This change in attitudes, in combination with all the other changes in individual determinants, may lead to a delay in sex or a reduction in the frequency of sex, which finally will lead to a reduction in pregnancy.

Similarly, this logic model specifies that accurate information about the risks of sexual activity, in combination with a number of interactive activities designed to get the students to personalize the information, will increase students' perceived risk and costs of becoming pregnant if sexually active. On the second page of this figure, this logic model specifies that providing materials to help parents clarify and express their personal values about sexuality coupled with homework assignments in which students ask their parents about family values will increase their beliefs that

family values support abstinence. Other activities on the third and fourth pages are designed to change the determinants of contraceptive use and thereby increase contraceptive use among sexually active youth.

Clearly, this logic model is designed not as an overview, but to specify more detail about the kinds of activities that will be included in the curriculum and which activities are believed to affect which determinants.

This particular logic model has not been used in any single intervention. However, it includes elements from the curricula and theoretical models of several curricula that effectively delayed sex or increased condom or contraceptive use (Jemmott, Jemmott & Fong, 1998; St. Lawrence, Jefferson, Alleyne & Brasfield, 1995; Coyle, Basen-Engquist, Kirby, et al., 2001; Kirby, Barth, Leland & Fetro, 1991).

This model assumes that ultimately it is the behavior of individuals that needs to be changed in order to achieve a health goal. However, the focus does not always need to be on changing individual behavior. For example, if a health goal involves decreasing air pollution, then it may be the behaviors of companies or governmental agencies that should be changed and should be specified in the logic model.

Example of a logic model focusing upon non-sexual determinants and youth development programs. Figure 6 provides a second example of a logic model that is also based upon the causal model in Figure 4. Whereas Figure 5 illustrates an example that focuses upon individual attributes, particularly determinants involving sexuality, and could be used in designing a sex education curriculum-based intervention, Figure 6 illustrates an example that focuses primarily upon non-sexual determinants and non-school youth development programs to change those determinants.

It includes: 1) training and other efforts to improve teachers' teaching skills, 2) tutoring programs, 3) sports programs for girls, 4) mentoring programs, 5) programs for parents to help them clarify their values about sexuality, express those values to their children, become closer to their teens, monitor their teens appropriately, and aid them in preventing their teens from going steady with much older partners, and 6) service learning programs that combine voluntary service with small group meetings to prepare for and debrief the voluntary activities. Most of these programs have the potential for addressing determinants both of sexual involvement and contraceptive use and thereby preventing teen pregnancy.

Although some of the programs identified in this logic model have evidence that they reduced either sexual risk-taking or actual pregnancy, this model is only an example. It is not meant as the best or ideal BDI model for any particular community. Furthermore, it is rather resource intensive.

This logic model includes a slight deviation from the steps described above. Note that at the bottom of the first page of Figure 6, there is an arrow going directly from the box identifying community service programs with group sessions for reflection to the box identifying delay in initiation of sex and reduction of frequency of sex; it does not go to any box in the determinants' column. This deviation reflects the fact that research demonstrates that service learning can delay sex but has not yet determined which determinants of sex are affected by service learning. Similarly, on the second page of Figure 6, the arrow goes all the way to reduction of teen pregnancy because other research

indicates that service learning can reduce teen pregnancy but has not specified which behaviors or determinants it changes.

More Complex BDI Models: Adding Columns and Nesting Models

BDI logic models are designed to simplify reality in order to facilitate the design and evaluation of interventions to achieve a health goal. However, reality is complex, and sometimes the four basic steps (or columns) in logic models oversimplify a complex reality. Thus, sometimes additional columns need to be added or models need to be nested within each other in order to better capture important aspects of that reality.

Adding an additional column

Many professionals believe that if reproductive health clinics are more "adolescent friendly," then youth are more likely to use them. That is, they believe that the behavior of clinic staff affects whether or not youth use clinics for reproductive health care, whether they return for subsequent clinic visits, and how consistently and properly they use contraception. Given these beliefs, suppose, for example, that the administration of a particular health clinic wants to increase correct and consistent contraceptive use among sexually active youth by changing staff behaviors toward youth. In this example, the clinic administration should identify reducing teen pregnancy as the health goal and increasing contraceptive use as the behavior that will help them achieve that goal and that they will try to change (See Figure 5). The question then arises: How should they include the behaviors of the staff in the model? One reasonable way is to identify the important staff behaviors as determinants of the teens' contraceptive behavior and to then specify intervention activities to change the staff's behavior. This approach would fit nicely into the four columns of the basic BDI logic model framework.

However, if the clinic administration recognized that changing staff behaviors is not a simple or certain process, they might want to identify the important determinants of the staffs' behaviors and then design policies, conduct trainings, provide materials, and complete other interventions for each of those determinants. Taking these steps obviously requires an additional column such that the teens' contraceptive behavior, the staff's behaviors, and the determinants of the staff's behaviors are all presented in three different columns. Adding an additional column solves this problem. An example of such a model is presented in Figure 7.

Despite the addition of a fifth column, this model still incorporates the basic concepts of BDI logic models, was created in the same manner as the other models, and should be interpreted in the same way.

This model, like all the other models presented in the paper, is not presented as the best possible model of "adolescent friendly" clinics, for it does need to be developed further. However, there is research indicating that when clinic staff engage in some of the behaviors identified in this model,

then teens are more likely to use contraception correctly (Boekeloo et al, 1999; Danielson et al, 1990; Orr et al., 1996; Winter & Breckenmaker, 1991).

Nesting logic models

Commonly, the basic four-column BDI logic model can well represent the reality that program designers are trying to capture when designing effective programs. The model in Figure 5 is a good example; all the intervention activities are designed to address determinants of individual sexual or contraceptive behaviors that, in turn, affect the health goal. Thus, four columns were sufficient. Sometimes a fifth column is necessary to reflect the fact that all the intervention activities address the determinants of the behaviors of one or more groups of people who, in turn, affect the behavior leading to the health goal. The model in Figure 7 is a good example; all the intervention activities are designed to address the determinants of clinic staff behaviors that, in turn, will affect the contraceptive behaviors of teens and thereby reduce teen pregnancy. Thus, adding a fifth column provided a neat solution for that model.

However, sometimes, reality is still more complex and can best be modeled by "nesting" logic models within each other. "Nesting" refers to the process of creating one or more detailed logic models (or portions of logic models) that fit within a larger model but for purposes of presentation on the written page, are presented separately. Nesting is most useful when logic models include both determinants of behaviors that directly affect the health goal *and also* determinants of behaviors by either the same individuals or other groups that directly affect other behaviors and thereby *indirectly* affect the health goal. That is, they are most useful when some portions of the logic model would be best represented by a four-column model and some portions by a five-column model. An example will make this more clear.

In Figure 8, it is hypothesized that initiation of sex and frequency of sex are affected by use of alcohol, parent-child communication about sex, and individual attitudes, perceptions, beliefs, and self-efficacy about sex. Because in this model it is believed that teens' use of alcohol affects their sexual behavior and that decreasing use of alcohol will be a significant component of the intervention, the determinants of use of alcohol and the intervention components addressing each of those determinants need to described more precisely. While determinants and intervention components could be identified to the left of the box stating "Decrease use of alcohol" in Figure 8, it is simply more clear to create a separate model identifying the determinants and their respective components in Figure 8A.

Similarly, because this model hypothesizes that parent-child communication about sex affects sexual behavior and that increasing parent-child communication about sex will be a significant component of the overall intervention, the determinants of parent-child communication about sex and intervention activities to address are presented. Again, it is more clear to present these determinants and intervention components in a separate model (Figure 8B) than to squeeze them into the left of the box in Figure 8.

These examples appropriately demonstrate that nesting can allow BDI models to represent how behaviors by either the same individuals (e.g., the teens themselves) or others (e.g., their families, their teachers, or clinic providers) affect their behaviors which, in turn, affect the health goal.

Addressing disparate health goals or behaviors

Typically when creating a BDI logic model, a single health goal is specified. If a community has multiple health goals, then a separate logic model can be developed for each health goal. However, occasionally, different health goals may involve some of the same behaviors, and when this is true, it can be helpful to link the logic models (i.e., have the models refer to one another) or to actually integrate the multiple health goals in the same logic model.

For example, some organizations are concerned with reducing both teen pregnancy and teen sexually transmitted disease, and some, but not all, of the same sexual behaviors (e.g., abstinence, frequency of sex, and condom use) affect both pregnancy and STD. Thus, it may be helpful to develop either linked or integrated models for both of these health goals.

Occasionally, youth-serving agencies may be concerned with quite disparate goals and behaviors among teens and may want to address some core set of risk and protective factors related to these disparate behaviors and goals. These common factors can be addressed by creating separate models, specifying the different health goals and behaviors to be changed, as well as the determinants of those behaviors, and then selecting those determinants that are common to several of them (e.g., attachment to adults, connectedness to school, belief in the future, and personal competencies). Of course, if an agency specifies first the program, then the determinants, and finally the behaviors or health goals, then they are creating logic models, but not BDI logical models because they have completed the steps of creating a logic model in the reverse order.

Criteria for Assessing Logic Models

After completing a logic model, people may ask: Is this a good one? How can it be improved? Figure 9 presents numerous criteria for judging a logic model. The criteria presented there naturally follow from many of the questions and criteria provided above to help you develop your models.

Planning For and Using Logic Models

Who should be involved in the development of BDI logic models?

It is not sufficient for an outside person to come in, spend a few hours creating a logic model for an agency, and then leave. Rather, BDI logic models become the most meaningful and most effective if diverse workgroups (as opposed to single individuals) are actively involved in developing, updating, and possibly using them. These workgroups should include program planners, people knowledgeable about the target group, people knowledgeable about relevant research, youth from the target group, staff, and other stakeholders in the community. If possible, these workgroups should also include people with a variety of perspectives on the issue. If the targeted group includes youth or other people who may have difficulty articulating their views in the presence of other community members or professionals, then it may be more productive to meet with them and gain their input in separate meetings.

Involving workgroups in the development of a logic model can:

- bring people with different views together,
- create a more common understanding and acceptance of the intervention's approach,
- increase commitment to evaluation and understanding of the results,
- increase cooperation among people in different agencies or sectors, and
- more generally increase stakeholder involvement and support.

What do we do with a logic model after we create it?

Logic models are likely to bring people together, improve the design of programs and facilitate evaluation, only if they are created, updated and used in an on-going process by the group. That is, workgroups should not create logic models and then file them away only to be forgotten. Rather, workgroups should continually review them and update them as new experience, research studies and other evidence inform the model, and agencies should use them in their ongoing development or refinement of programs, training of staff, and evaluation efforts. If logic models are to markedly affect people's thinking, their program design and their evaluation measurement efforts, then these people must put a considerable amount of time and thought into the creation and maintenance of the models.

More specifically, on an on-going basis the following tasks should be completed:

- Other interested groups should review the logic model and make suggestions.
- People should review relevant existing research on the determinants of the selected behaviors and on the impact of programs designed to change these determinants or behaviors, and then update the model.

- Additional research questions on important determinants should be identified and answered with focus groups, other qualitative research or survey research. University research groups or other researchers should be encouraged to address the research needs.
- Formative research on the program should be completed. For example, simple focus groups can be conducted to assess whether the participants believe the interventions are having an impact upon the specified determinants. Similarly, simple pre-post questionnaire surveys can determine whether the interventions are having a short-term impact upon the determinants. If not, the model and/or the intervention should be revised.

Obviously, logic models will not have much effect, even if they are refined, if they do not form the basis for actual programming and evaluation. In regards to programming, this means that the intervention components specified in the logic model are the interventions that must be designed and actually implemented. For example, the activities specified in the logic model in Figure #5 become the basis for a curriculum. Understanding the logic model must also become part of staff training. For example, when staff are trained to implement a new curriculum, they should understand why particular activities are important (i.e., which determinants they are trying to affect with a particular activity). Understanding the purpose underlying an activity can help them make their points more clear and get their messages across.

Guide for the Specification of Indicators for Process and Impact Evaluations

While a primary reason for developing logic models is to develop more effective programs that change behavior, the creation of logic models can also be a very useful step, perhaps even an essential step, in conducting program evaluations. Regardless of whether or not evaluations are process or outcome, or qualitative or quantitative, at some point, they need to assess whether critical program components or activities were implemented or whether they had an impact upon mediating outcomes, important behaviors and overall health goals. Consequently, identifying the critical program components or activities, the mediating outcomes (which are the determinants of the specified behaviors),[6] the important behaviors and the health goals is a necessary first step. Without this specification, evaluators may assess the wrong program activities or measure the impact of the program upon the wrong outcomes. This, of course, can be very unfair to the programs. If an evaluation measures the impact of a program upon the wrong outcomes, it may incorrectly conclude that the program failed to have an impact, when, in fact, it did. If the elements in a BDI model are specified properly, they can become the guide for the important program characteristics and outcomes to be measured.

[6] When designing programs, it is more common to talk about the "determinants" of behaviors, whereas when evaluating the impact of programs, it is more common to talk about "mediating" outcomes, that is, the outcomes that "mediate" between the intervention activities and the behaviors. Despite their different words, they refer to the same things.

What should be measured?

Evaluators conducting a process evaluation of the intervention summarized in Figure 5 would need to assess the implementation of all the curriculum activities identified in the left-hand column. Such a process evaluation might include assessment of which activities were actually implemented by educators, what was the fidelity of that implementation, how many youth and how many parents received each activity, and what was their reaction to each activity.

When conducting an outcome evaluation, evaluators would need to measure the impact of the intervention upon the mediating variables (the determinants of behavior), the behaviors themselves, and the health goal. In the example in Figure 3, this would include measuring the impact upon mediating variables such as attitudes about abstinence and premarital sex, perceived risks and costs of pregnancy and STD, perceptions of peer sexual activity, etc. It would also include program impact upon initiation of sex, frequency of sex, use of contraception and pregnancy. Currently, there exist standardized measures of all these outcomes. These, then, could be incorporated into the construction of questionnaires for youth.

How can measurement of these indicators help us understand how or why our programs did or did not work?

In several different ways, measuring the impact of interventions upon mediating outcomes, behaviors *and* health goals can greatly increase our understanding of why programs either did or did not work. Ideally, the results of an evaluation will demonstrate that a program improved the determinants, behaviors and the health goal, and, in addition, the determinants are related to the behaviors which, in turn, are related to the health goal. Sometimes results are this positive.

However, frequently, the results are not so positive. Several different situations can occur, and proper analysis of the data can be informative:

- ***First, interventions may not markedly affect the determinants (mediating outcomes), behaviors, or health goal.*** This means that the programmatic components were just not sufficiently powerful to change the determinants, and that more powerful components should be designed.

- ***Second, interventions may markedly affect the mediating outcomes, but not the behaviors.*** This is important to know because it tells us that the specified determinants must be improved even more and/or *other* determinants/mediating outcomes must be changed before the behaviors will change significantly. Identifying those other determinants and how to change them then becomes an important task.

- ***Third, interventions may change behaviors, but not markedly change the specified determinants.*** (Believe it or not, this sometimes happens.) This is important to know because it means that the intervention is affecting other unspecified and unmeasured determinants that are, in turn, affecting the behavior. By subsequently identifying those determinants, it may be possible to fine tune the intervention and make it either more effective or more efficient.

- ***Fourth, interventions may have an impact upon behaviors, but not upon the health goal.*** This is important to know because it tells us that either other behaviors must be changed in order to achieve the health goal, or alternatively, that the improvement in behaviors may have led to some improvement in the health goal, but for measurement and statistical reasons, it was simply not possible to detect that small improvement and greater change in behaviors is needed to achieve the health goal.[7]

In general, an assessment of the impact of interventions upon mediating outcomes/determinants, behaviors and the health goals can increase our understanding of how or why the intervention either did or did not work and that assessment can typically guide subsequent program improvement.

The data collected on determinants, behaviors and health goals can also increase our understanding of the relationships among the determinants, behaviors, and health goals. That is, statistical analyses of these data can provide more information about the relative impact of different determinants on each behavior, and sometimes they can provide more information about which behaviors most directly affect the health goal. This information can then lead to the development of subsequent, more evidence-based logic models.

Unsuccessful and Successful Applications of BDI Models

While the development of BDI models may seem logical, appealing and desirable to some people, a critical question remains: Can they actually improve the design and development of programs and increase their chances of changing behavior? A review of research on programs to reduce adolescent STD/HIV and pregnancy in the United States indicates that they can be effective, but only if they are properly designed and applied.

In the United States in the 1980s, a commonly recognized problem was the very high rate of unintended teenage pregnancy. After researchers documented that young people believed many myths about sexuality and contraception, many schools implemented sex education programs to increase knowledge about sexual behavior and contraception (and to reduce the prevalence of the myths) and to thereby reduce unprotected sex and pregnancy. Curriculum developers believed that if programs increased adolescent knowledge about the risks of sexual intercourse and the effectiveness of abstinence and contraception, then youth would be less likely to engage in unprotected sex. Evaluations of these knowledge-based programs revealed that they did increase adolescent knowledge, but they did not significantly change behavior.

Why were they not successful at changing behavior? Subsequent studies revealed that, while teens did not have accurate knowledge about some aspects of sexual behavior and contraception, these beliefs were only weakly related to actual sexual and contraceptive behavior. That is, knowledge was not an important determinant of adolescent sexual and contraceptive behavior. Thus, those sex

[7] Commonly, it is possible to measure the impact of programs upon the initiation of sex, frequency of sex, number of sexual partners, and use of condoms or contraception, but for both methodological and statistical reasons, it is often difficult to measure the impact of interventions upon pregnancy or STD rates.

education programs focused upon the wrong determinants; they focused upon a determinant that they were able to change markedly (knowledge), but that determinant did not markedly affect behavior.

A subsequent generation of programs focused upon generic values clarification and generic decision-making and communication skills. Although there were few evaluations of these programs, the available evidence suggests that these programs did help clarify values, and did help teach (to a slight extent) general decision-making and communication skills, but these programs apparently failed to reduce adolescent sexual risk-taking behavior (Kirby, 1985). Again, clarity of general values and very general decision-making and communication skills were not important determinants of sexual risk-taking. In addition, the programs had only a very modest impact upon these determinants.

Thus, these first two generations of ineffective programs either were not based upon logic models, or were based upon logic models with little research support and with the wrong determinants specified.

A more recent generation of programs focused more clearly upon specific behaviors, reviewed research and theory to specify the important individual determinants of these behaviors to be changed, and designed program activities to change these determinants. In other words, they employed research-based BDI logic models. In some cases, they rather consciously created BDI models similar in form to the models discussed in this paper, while in other cases they employed the principles of BDI models without realizing that they were actually creating such models. Most important, these programs have rather consistently been effective — they have changed both the specified determinants of sexual, condom or contraceptive behavior, and the actual behaviors themselves (Kirby, 2001).

For example, *Safer Choices*, a theoretically based, multi-component, HIV, STD and pregnancy prevention program for high school youth, identified the behaviors leading to pregnancy, STD and HIV and addressed the determinants affecting those behaviors. Research results revealed that over a 31-month period, it effectively improved knowledge about HIV and other STDs, self efficacy to use condoms, normative beliefs and attitudes about condom use, perceived barriers to condom use, perceptions of risks of HIV and other STDs, and parent-child communication about sexual behavior. Consequently, it, in turn, increased condom use, increased contraceptive use, decreased the frequency of unprotected sex, and decreased the number of sexual partners with whom condoms were not used (Coyle et al., 2001).

Research in other areas has also indicated that BDI models have helped develop effective programs. For example, reviews of effective drug prevention programs have also found that they incorporate at least some of the elements of research-based BDI models (c.f., Dusenbury and Falco, 1995).

Building a Cumulative Body of Theory and Understanding of What Works and Why It Works

Increasing understanding of what works and why it works will enable people to develop more effective programs. That is, as research provides more information about what kinds of programs change particular determinants and which determinants are most highly related to behavior, then people can develop more effective programs. Clearly, logic models are an essential and integral tool in this process.

What is an example of how logic models advance theory?

An example of how logic models and program evaluations together can advance both theory and understanding of what works and why is the *Draw the Line* project (Coyle et al., forthcoming). That project focused upon the delay in the initiation of sexual intercourse among middle school youth as a method of reducing pregnancy and STD among these youth. Using a logic model and the best available research findings at the time of its development, it identified important determinants of initiation of sex for this age group (e.g., knowledge about sexuality, attitudes about having and not having sex, personal values about having sex, perception of peer norms about sex, self-efficacy to refuse sex, and clear sexual limits) and then developed curriculum-based activities to change those determinants.

In a large study, 19 schools were randomly assigned to receive *Draw the Line* or to receive the existing sex/HIV education classes. Survey data were collected from a cohort of students in these 19 schools before the intervention and multiple times after the intervention. This evaluation design and the survey data were then used to measure: 1) the impact of the intervention upon the determinants, 2) the relationship between the determinants and the initiation of sex, and 3) the impact of the program upon the initiation of sex.

The results were informative. They revealed that among boys, the *Draw the Line* intervention did improve some of the previously selected determinants, but not others, and did delay the onset of sex. Moreover, analyses of the relationships between the measured determinants and the initiation of sex revealed that some, but not all, of the previously selected determinants were related to the initiation of sex.

Among girls, the results were quite different. The *Draw the Line* intervention did not have a marked impact upon most determinants and did not delay the onset of sexual intercourse. Furthermore, the survey findings revealed that having an older boyfriend greatly increased the chances of the girls initiating sex. This factor was not recognized when the program was being developed and the *Draw the Line* program did not try to prevent girls from having an older boyfriend, nor did it address the additional pressures to have sex when a girl has an older boyfriend. In other words, for girls, the *Draw the Line* intervention did not focus upon one of the most important determinants and consequently did not change behavior. Knowing the importance of an older boyfriend, future programs can now focus upon preventing girls from having much older boyfriends (or can focus on

preventing the effects of having an older boyfriend) and therefore may be more effective at delaying sex.

In sum, by developing a logic model, by designing activities to change specific determinants of the initiation of sex, by developing measures of the determinants, by actually measuring the impact of the intervention upon the determinants and the initiation of sex, and finally by measuring the relationship between the determinants and the initiation of sex, this study advanced the understanding of: 1) the determinants of initiation of sex among middle school boys and girls, 2) the types of activities that can change these determinants among boys and girls, and 3) the types of activities that can cause males, but not females, to delay sex. Given this new understanding, future programs can be more effective in delaying the initiation of sex among younger youth.

Conclusions

For the purposes of designing programs that actually achieve desired health goals, it is important to complete the BDI model in the proper direction (health goal first, behaviors second, determinants third and intervention components fourth). It is also critical to base each part of the model upon the strongest evidence available (e.g., well established theory, previous research with similar populations, or optimally, rigorous research on the actual population to be targeted). If program designers simply start with their favorite program in mind and then search for determinants and behavior to justify that program, then the underlying logic of the BDI logic model is defeated, and interventions based upon the model are less likely to effectively change behavior. Similarly, if the model is not based upon strong evidence, the resulting interventions are less likely to be effective.

BDI models have been found to be a useful tool in the development of effective programs. In at least two areas of adolescent behavior, sexual risk-taking behavior and substance use, programs that were not based upon BDI models or did not employ the basic principles within them were much less likely to be effective. In contrast, those programs that were based upon BDI models or their principles were much more likely to change actual behavior.

In addition, when people use the procedures described in this paper to create BDI logic models, they are more likely to develop programs that are *comprehensive* (because they have identified all the important behaviors and determinants), *strategic* (because they have selected the most important behaviors and determinants), and *feasible* (because they have selected only those determinants and intervention components that they can actually implement given their possible resources). These are very important qualities of programs.

More generally, if developed properly, BDI models can help organize and clarify thinking about how interventions will change behavior; can encourage people to think precisely, causally, and hopefully realistically; can provide on-going direction to people actually implementing programs; can incorporate findings from theory and research; can provide clear guidance for what program activities to implement; can provide guidance for measurement in the evaluations of programs; and can help us build a more cumulative body of knowledge about what works and how it works. Needless to say, these strengths make them very useful.

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Figure 1:
An Example of a BDI Logic Model Identifying the Major Components of an Initiative To Reduce Unintended Teen Pregnancy

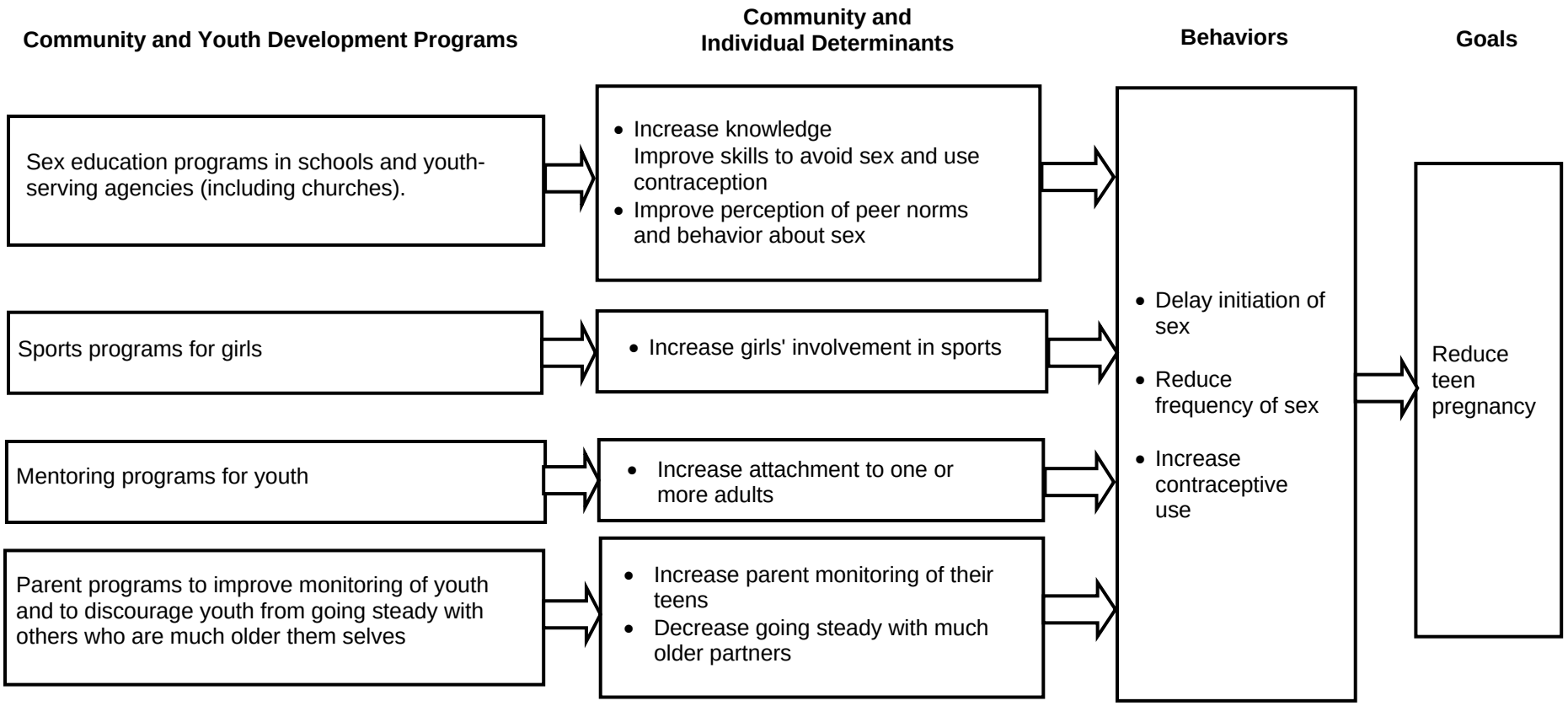
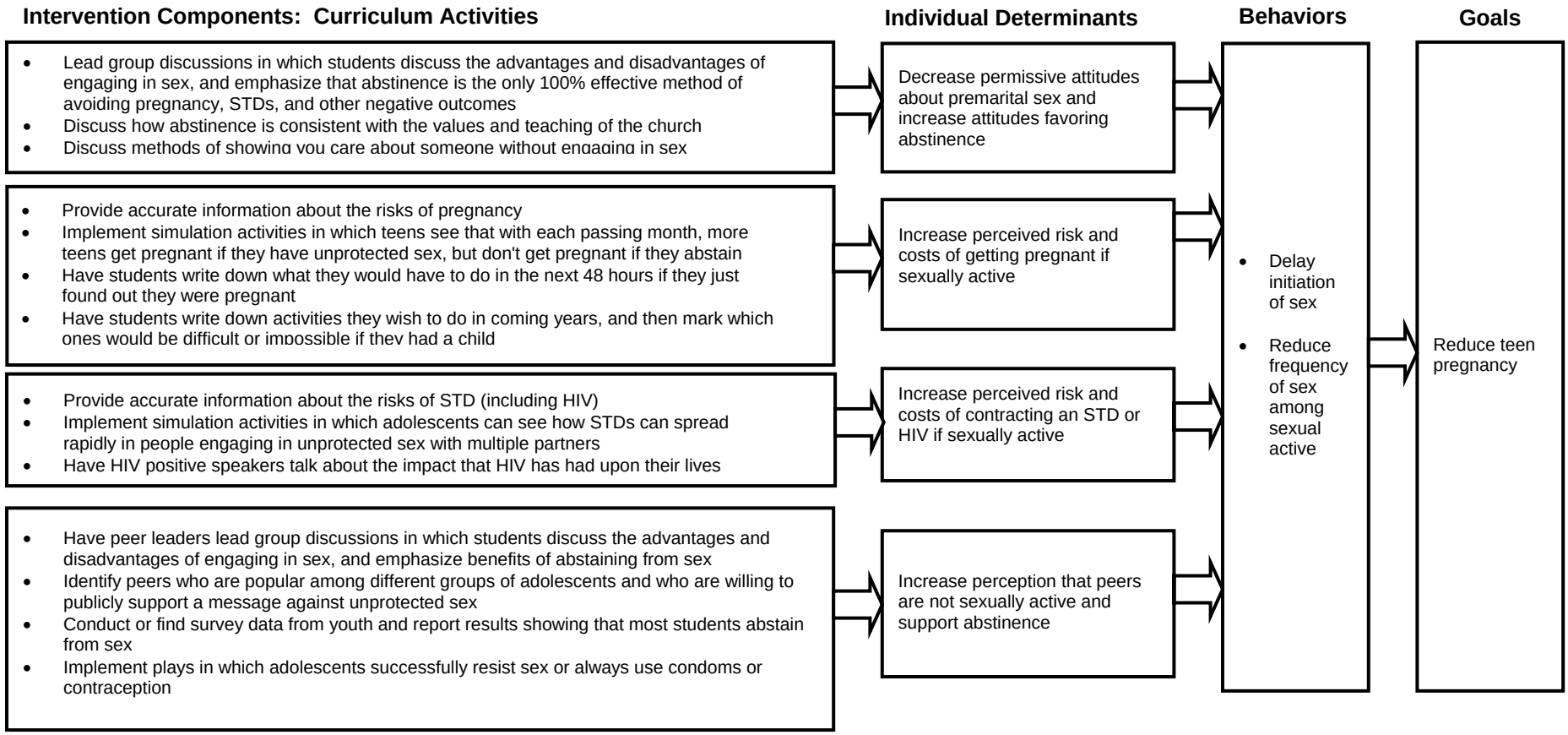


Figure 2:
A More Detailed Example of a BDI Logic Model to Delay or Reduce Sexual Activity And Thereby Reduce Teen Pregnancy By Implementing an Abstinence-Only Programs in Churches



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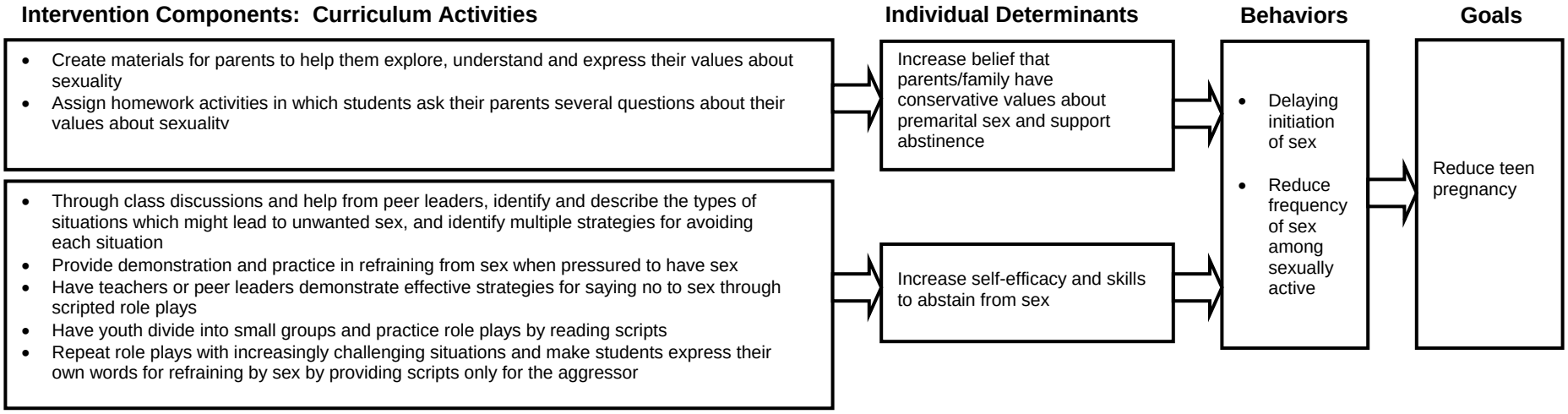


Figure 3:
Examples of Health Goals and Behaviors That Affect Those Goals

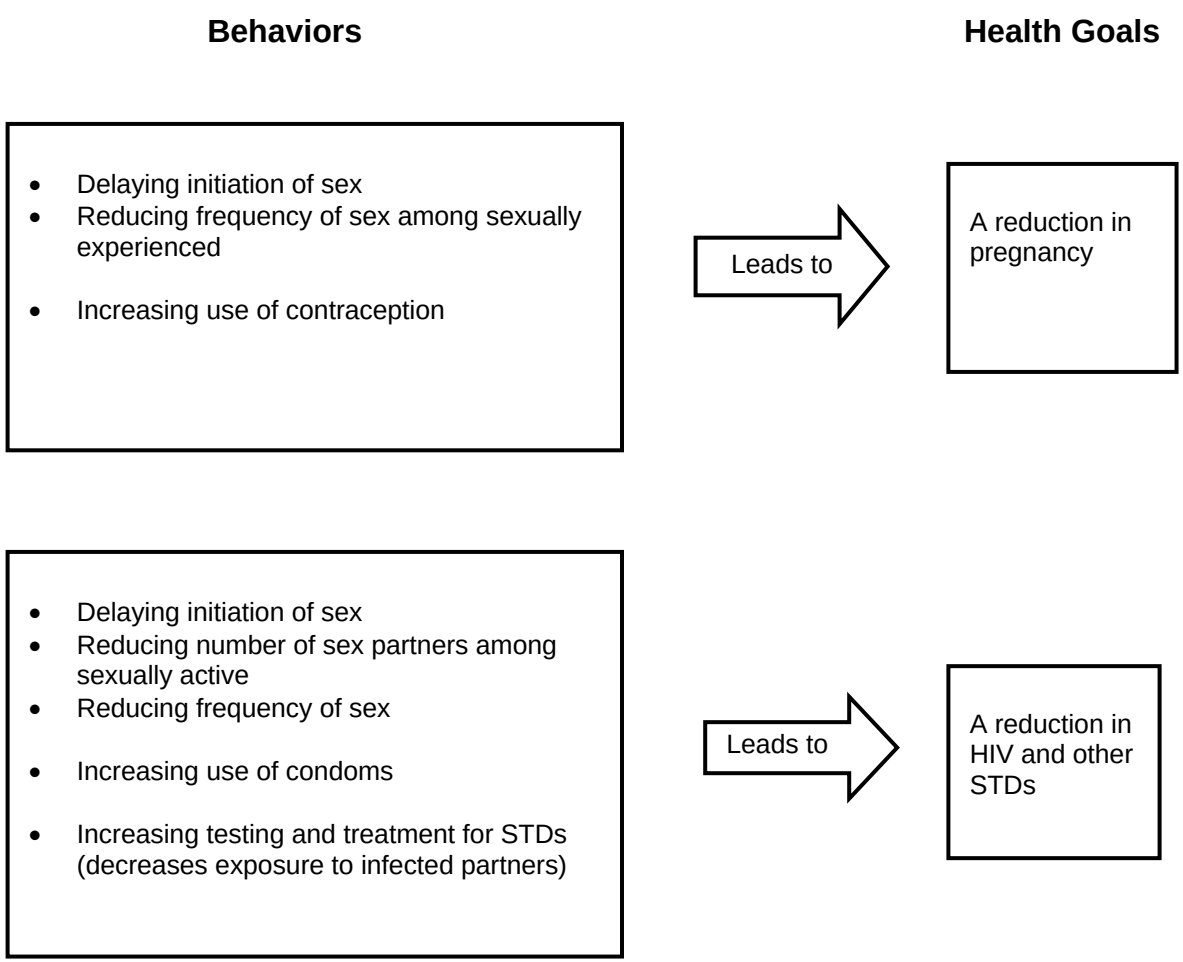


Figure 4:
Examples of Determinants that Affect Sexual Behaviors That, in turn, Affect Teen Pregnancy[8]

Determinants in Different Domains | **Behaviors** | **Goals**

Environmental Determinants

Community:
+ Higher level of education
- Higher divorce rate
- Higher rate of residential turnover
- Higher unemployment rate
+ Higher family income
+ Higher rates of participation in religious practices
- High crime rate
+ High neighborhood monitoring by adults in community

Family:
+ Higher parental education
+ Two (vs. one) parents
- Changes in marital status
+ Higher income level
+ Greater family religiosity
- Family depression and suicide attempts
- Single mothers' dating behaviors and cohabitation
- An older sibling who had sex
- An older sister who gave birth as an adolescent
+ Conservative parental attitudes about teen or premarital sex
+ Conservative parental attitudes about contraception

Peer:
- Peers and close friends who are older
- Peers with poor grades and high non-normative behavior
+ Friends with good grades and little non-normative behavior
+ Close friends closeness to parents
- Peers with deviant life trajectories
+ Peers with positive attitudes about preventive health
- Peers with permissive attitudes toward premarital sex
- Peers who are sexually active

Individual Psychosocial Determinants

Relationship with Family:
+ Greater closeness and connectedness to parents
+ More appropriate parental supervision and monitoring
+/- Greater parent/child communication about sex and birth control

Attachment to and Success in School:
+ Enrolled in school and attend school regularly
+ Better educational performance
+ Greater participation in and connectedness to school
+ Greater importance of academic achievement
+ Plans to attend college

Attachment to Faith Communities:
+ Greater religiosity
+ More frequent attendance at faith communities

Relationships with Peers:
+ Not being part of a peer group
- Being popular and engaging in many social activities with peers
- Engaging in physical fights

Relationships with Romantic Partners:
- Going steady with a boy/girlfriend and having a close relationship with partner
- Greater number of romantic partners

Healthful Behaviors:
+ Greater participation in sports
+ Greater involvement in other healthful behaviors

(Continued on next page)

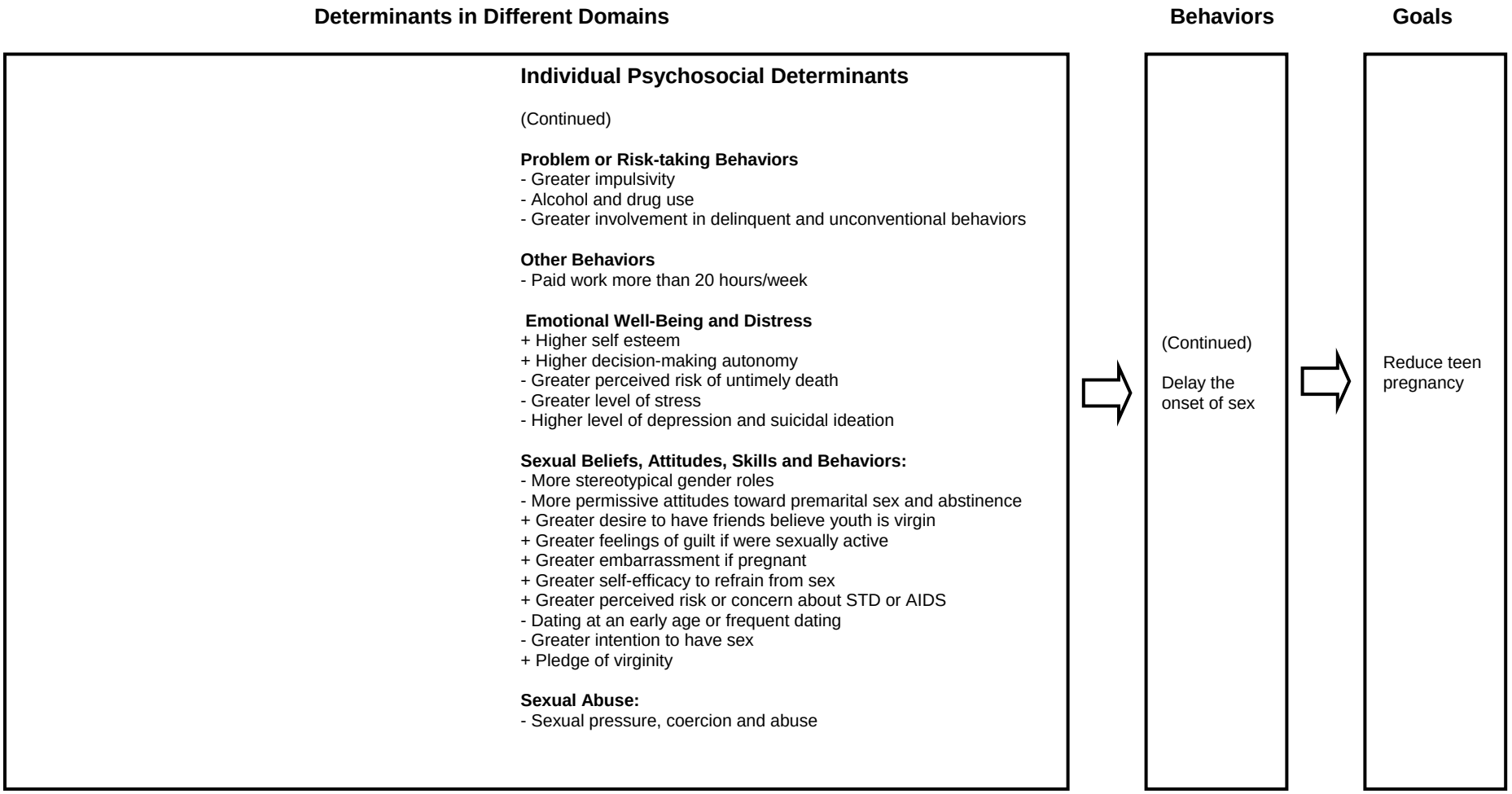
⇨ Delay the onset of sex

(Continued on next page)

⇨ Reduce teen pregnancy

[8] "+" denotes a protective factors; "-" denotes a risk factor.

Figure 4: Continued



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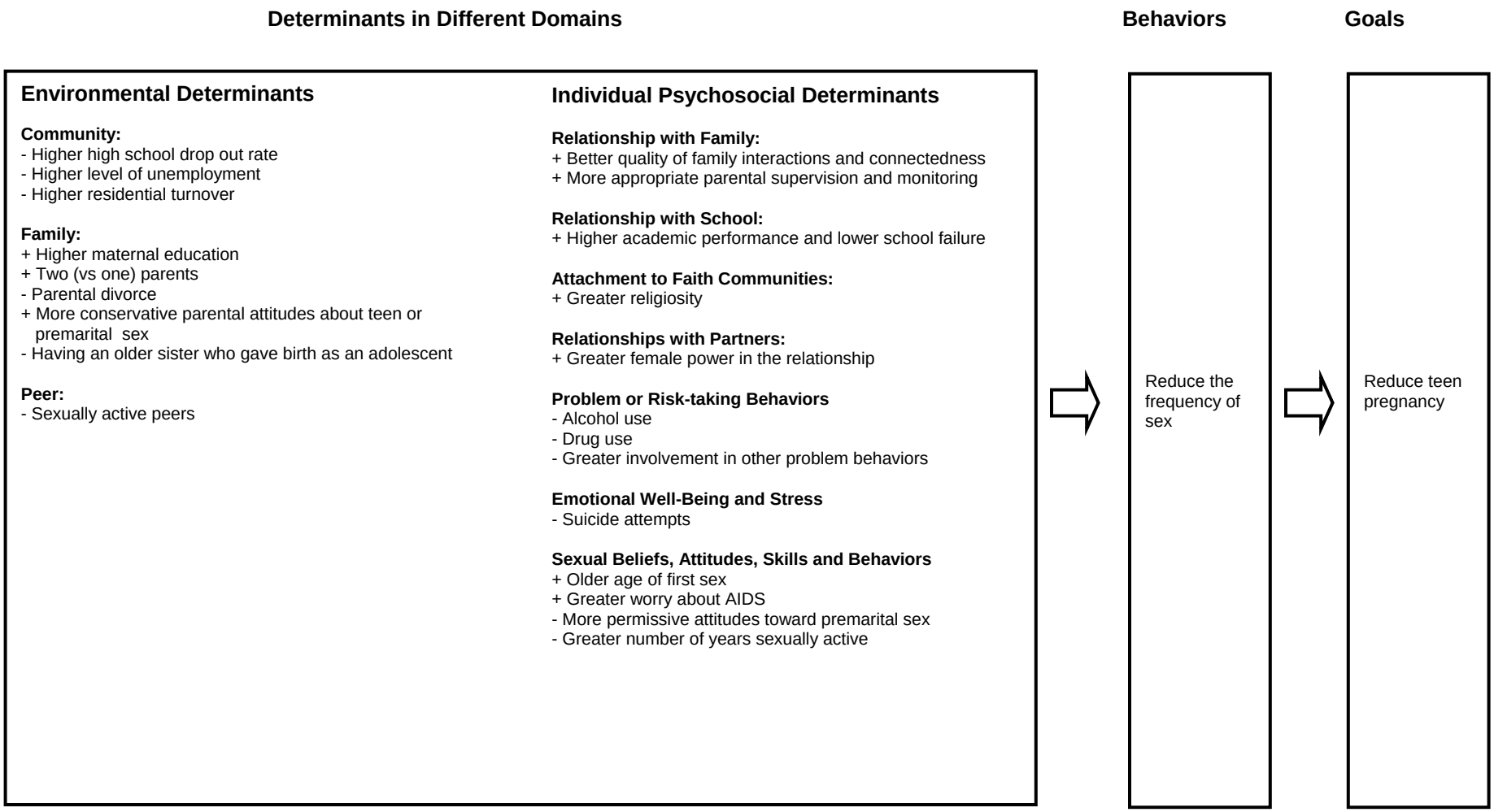

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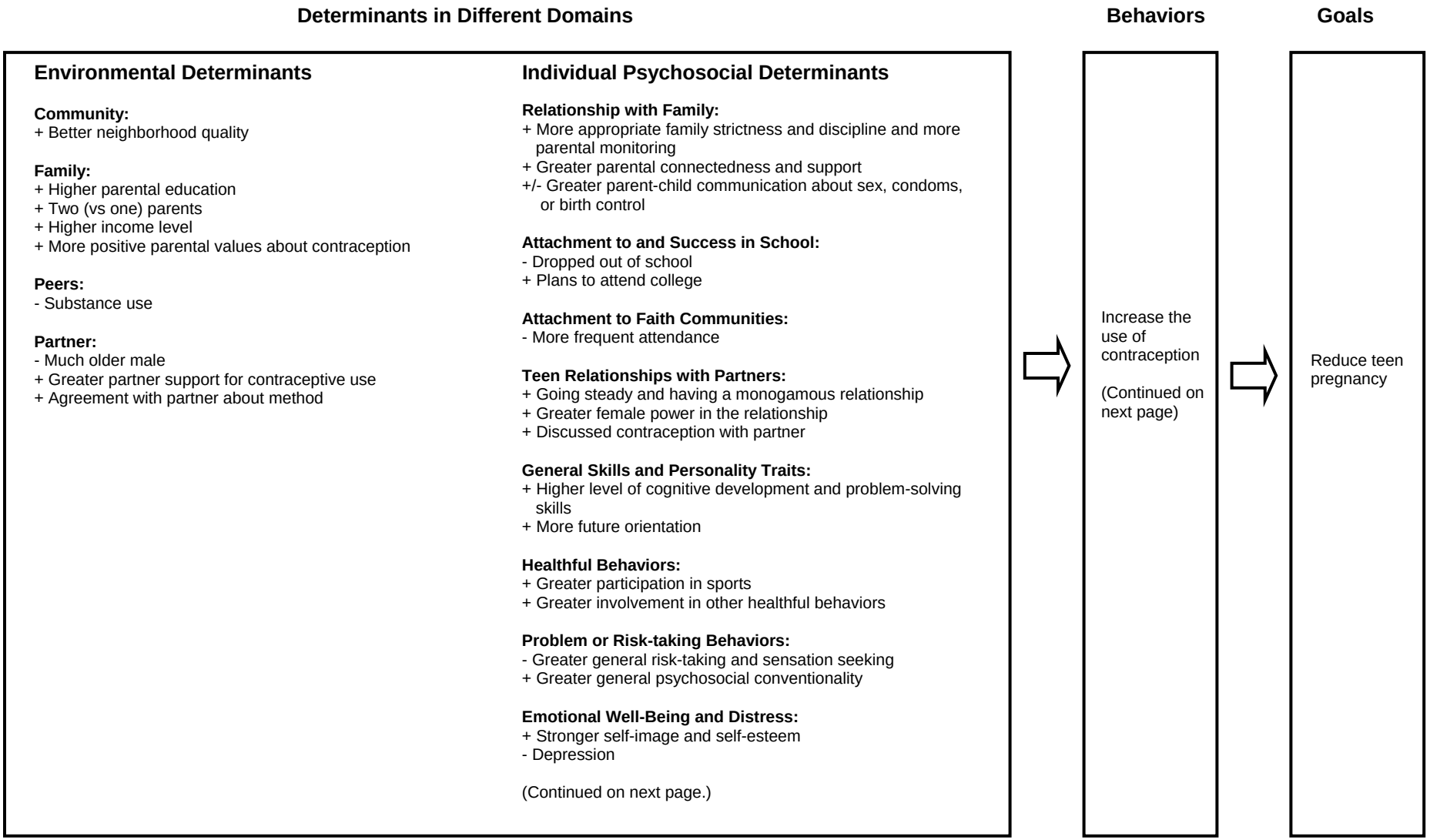


Figure 4: Continued

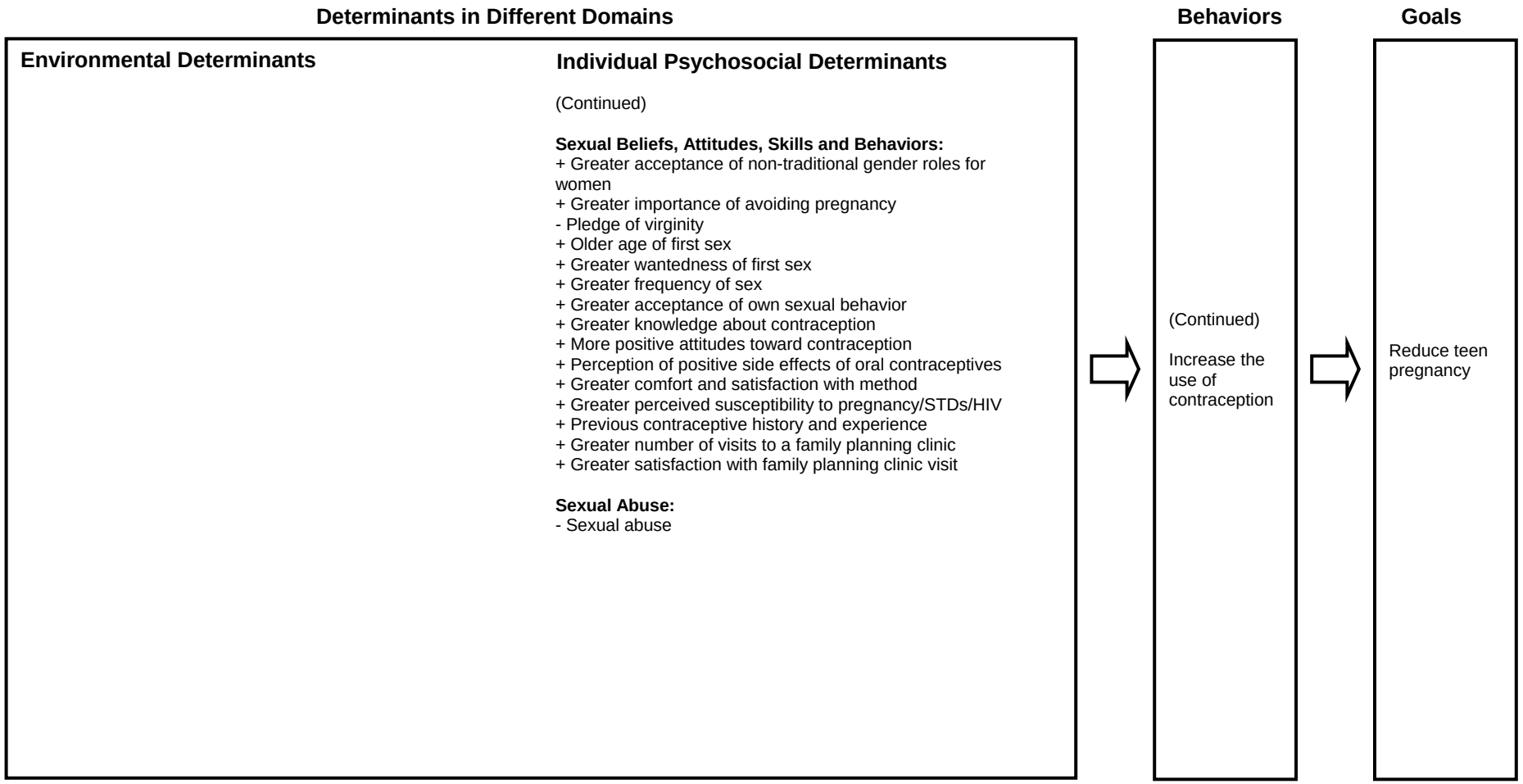
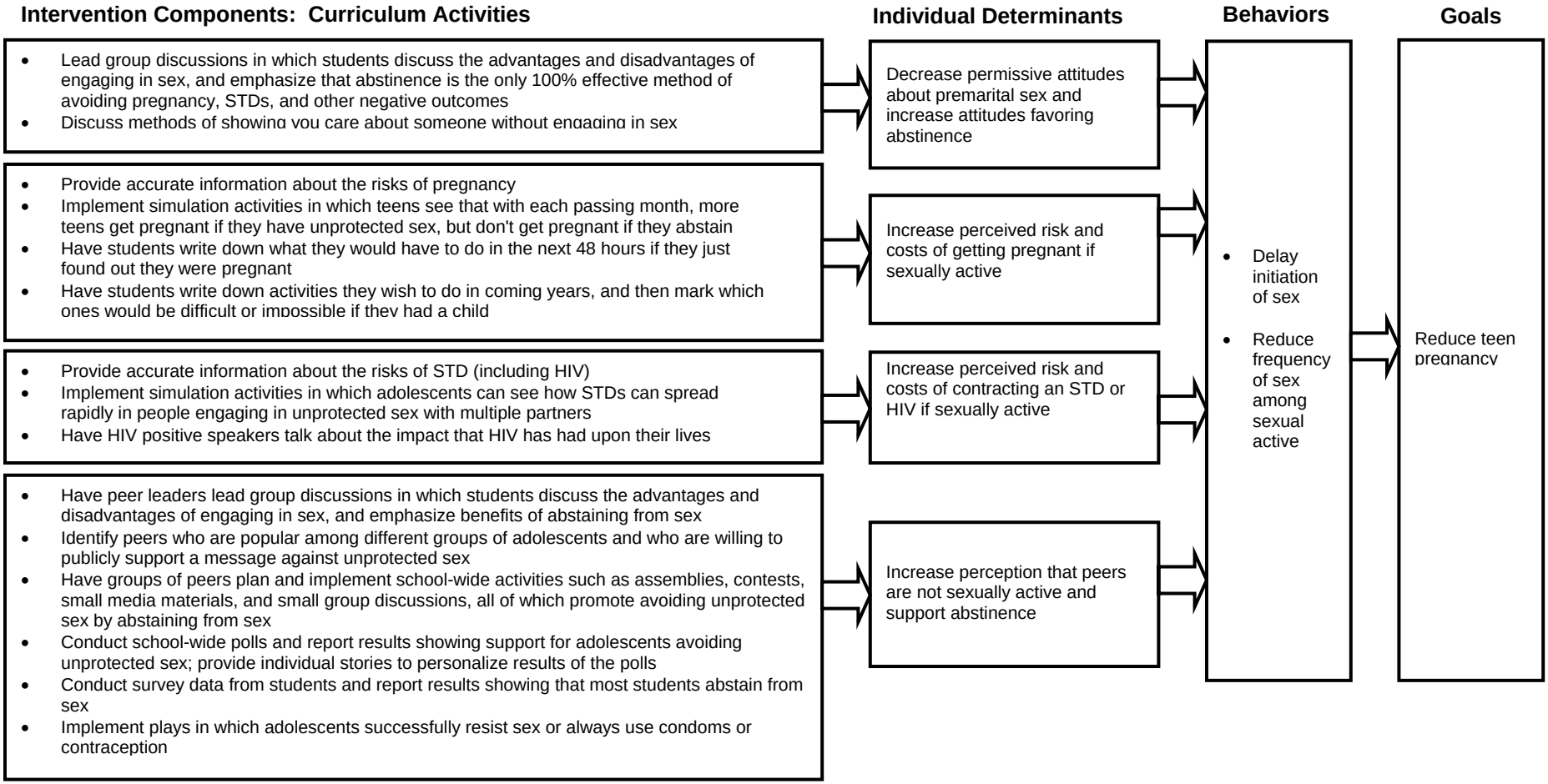


Figure 5:
An Example of a BDI Logic Model to Reduce Pregnancy
By Implementing a School-based Sexuality Education Curriculum
That Addresses Individual Psychosocial Determinants of Sexual and Contraceptive Behaviors



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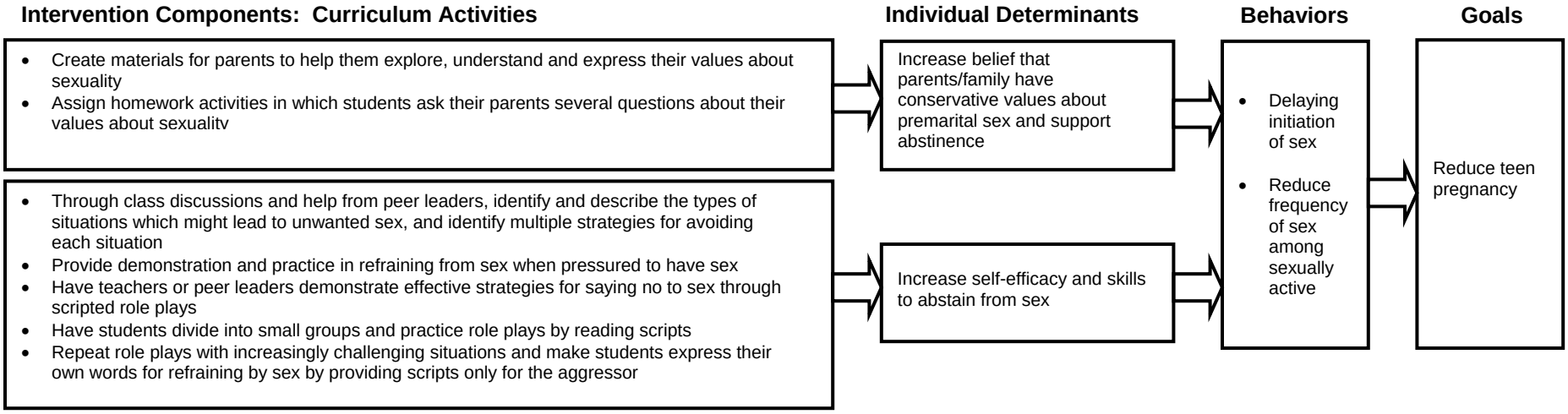

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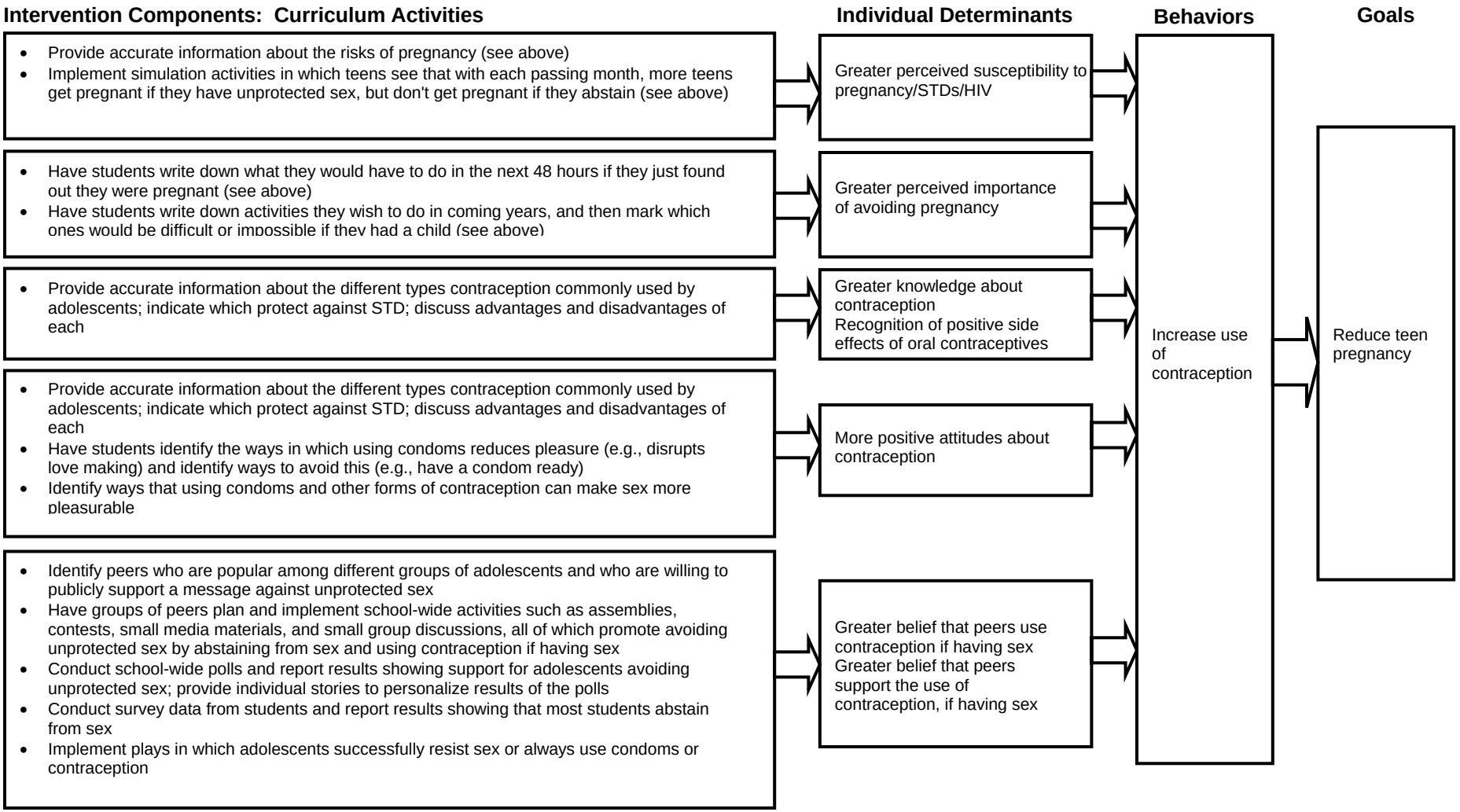

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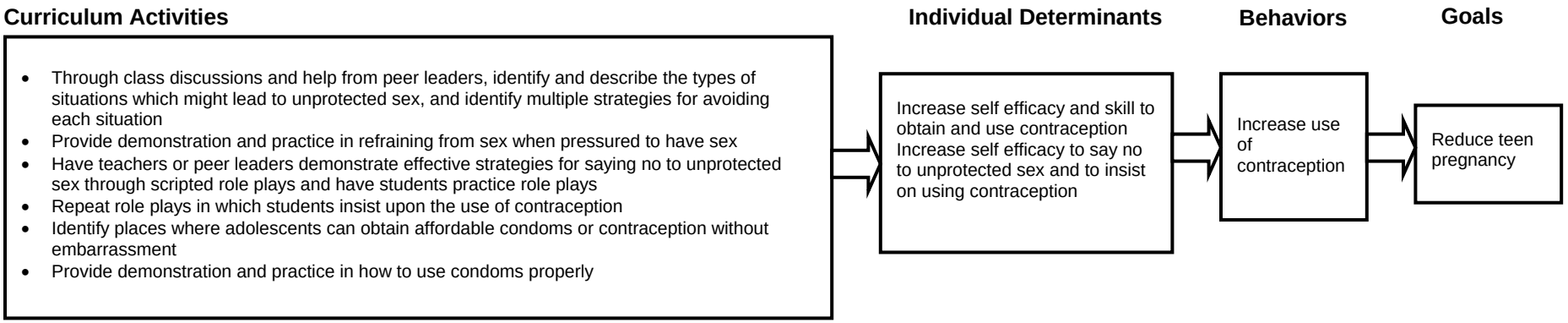
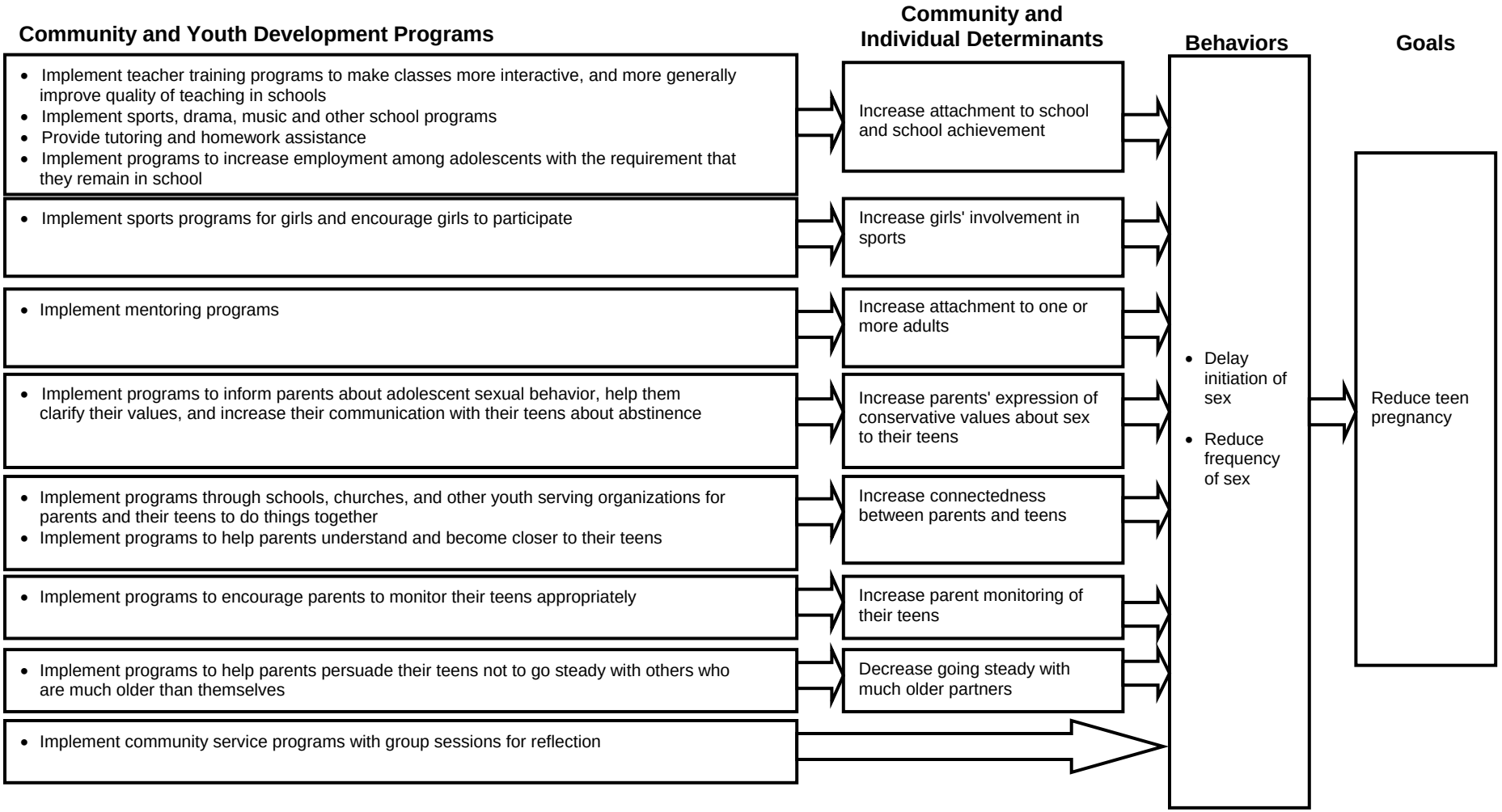


Figure 6:
An Example of a BDI Logic Model to Reduce Pregnancy through Youth Development Programs that Address Community and Individual Non-Sexual Determinants of Sexual and Contraceptive Behaviors and Pregnancy



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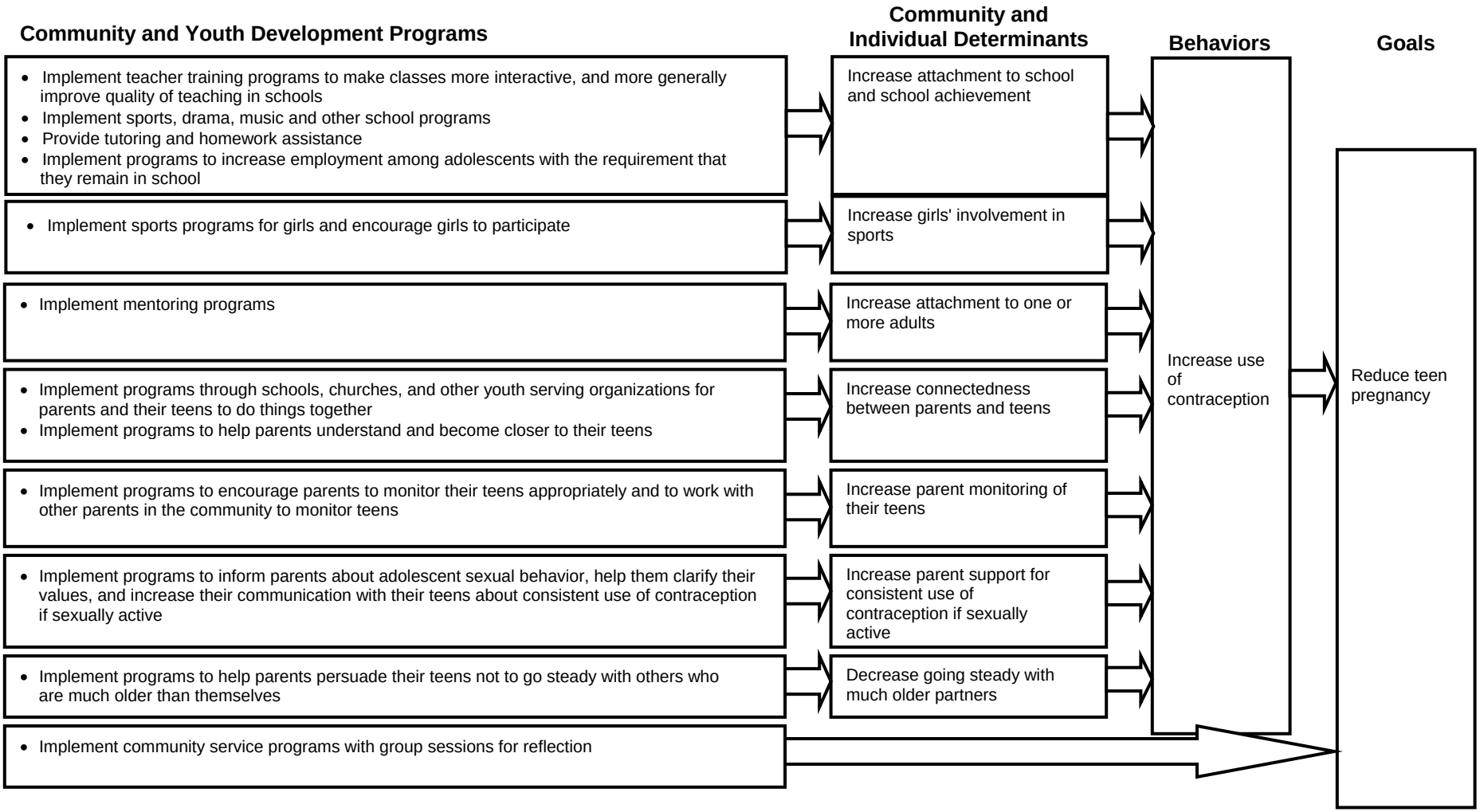
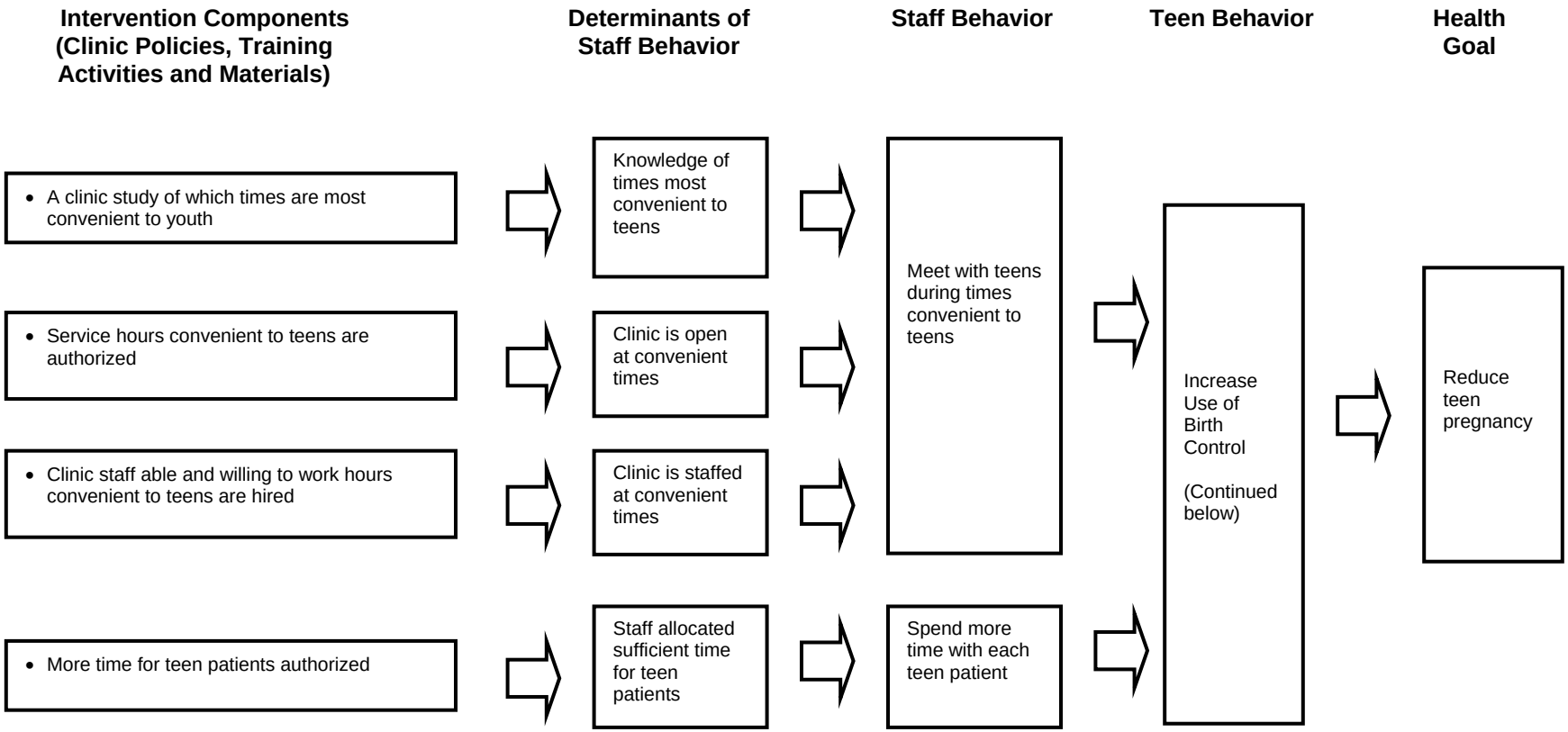


Figure 7: An Example of a BDI Logic Model to Reduce Pregnancy By Making Clinics More "Adolescent Friendly" and Thereby Increasing Teen Contraceptive Use



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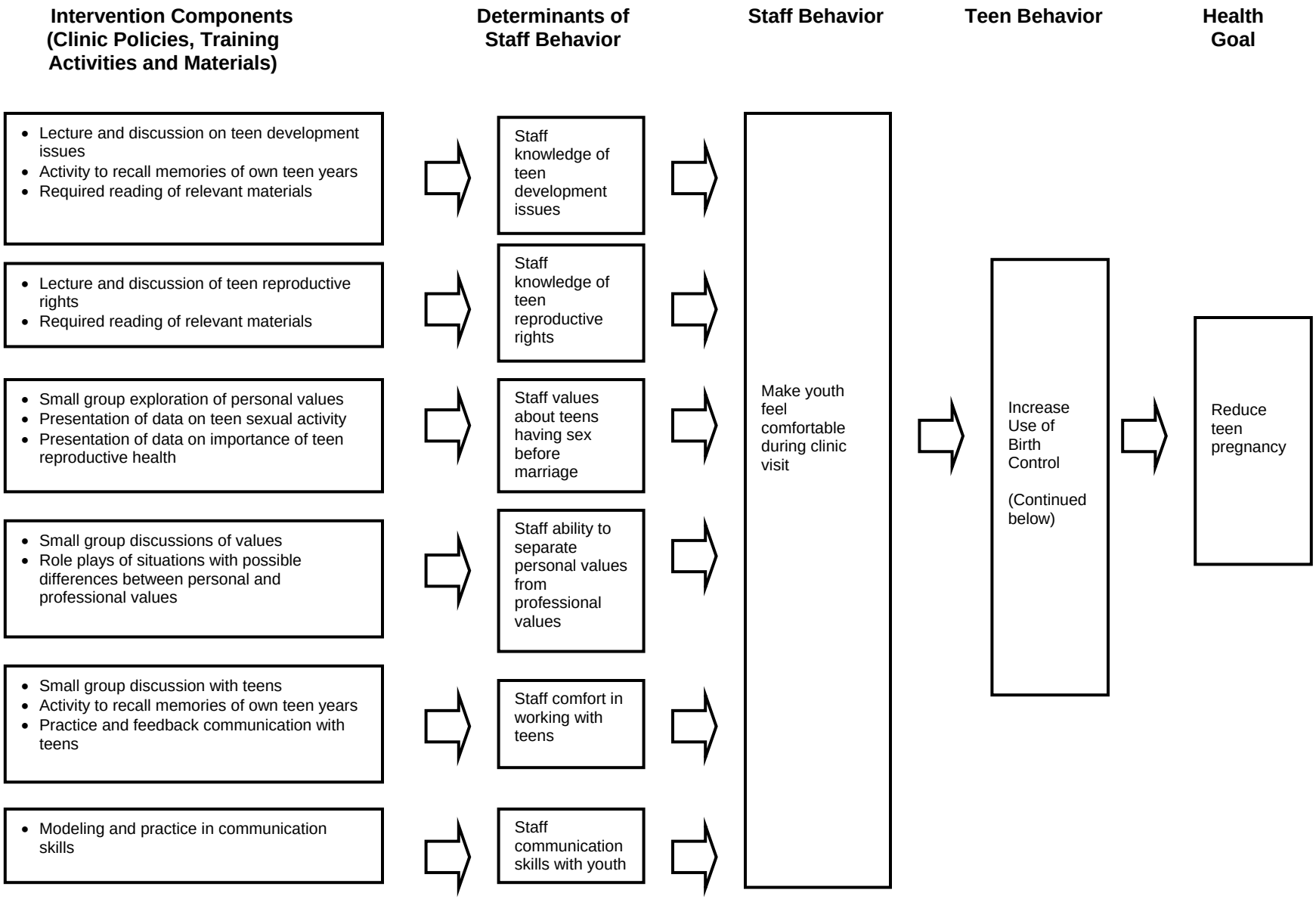

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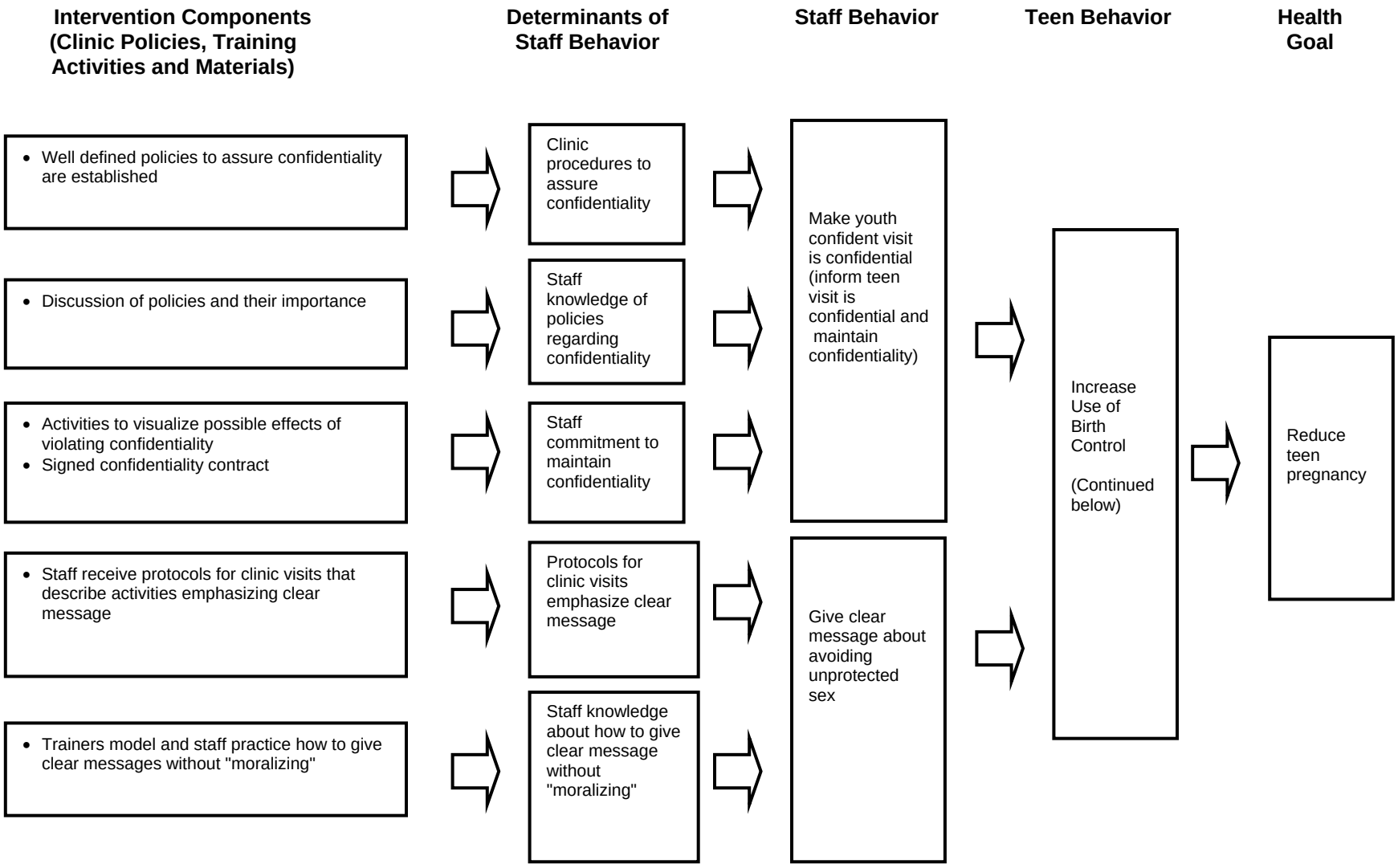

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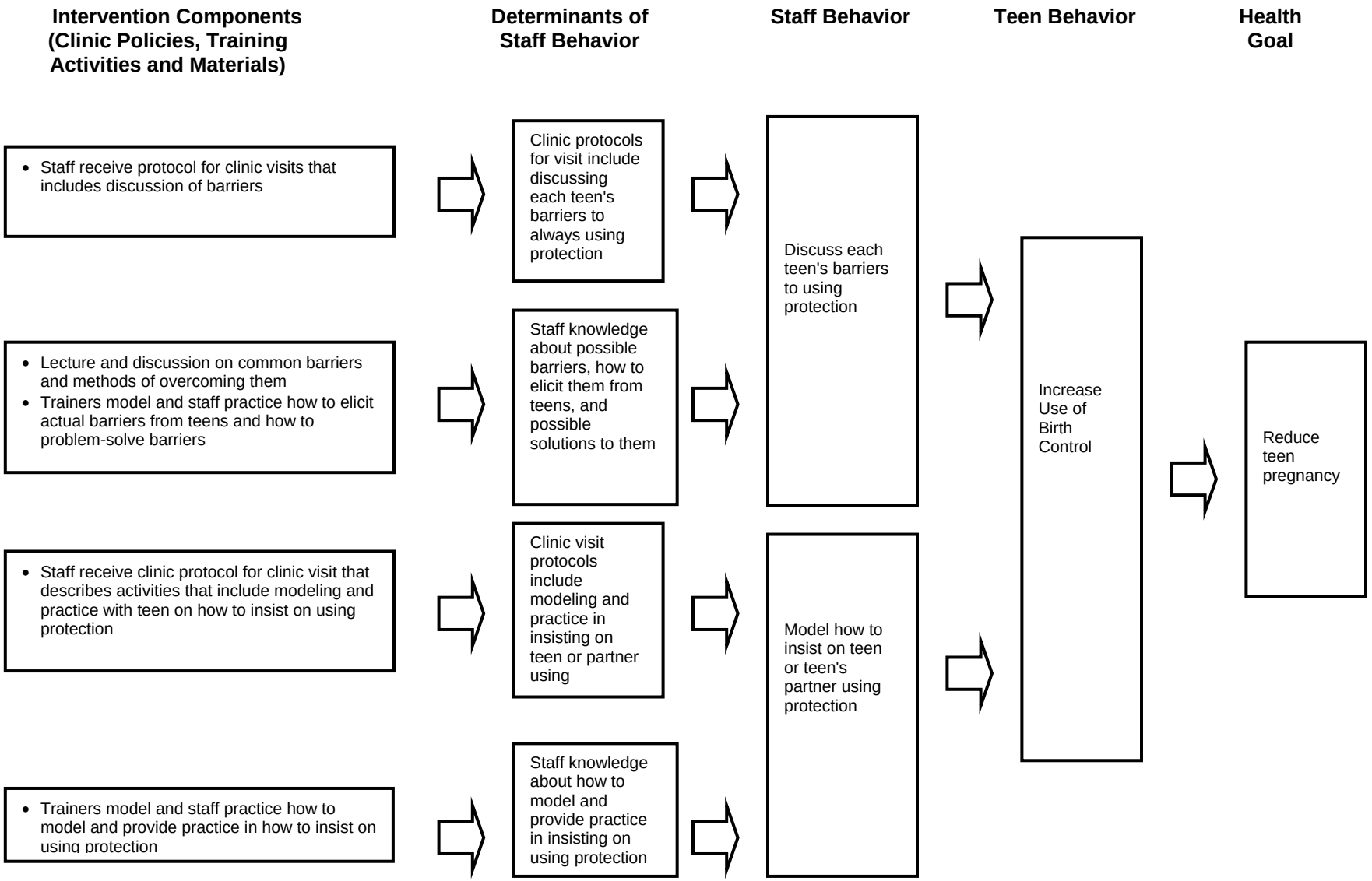
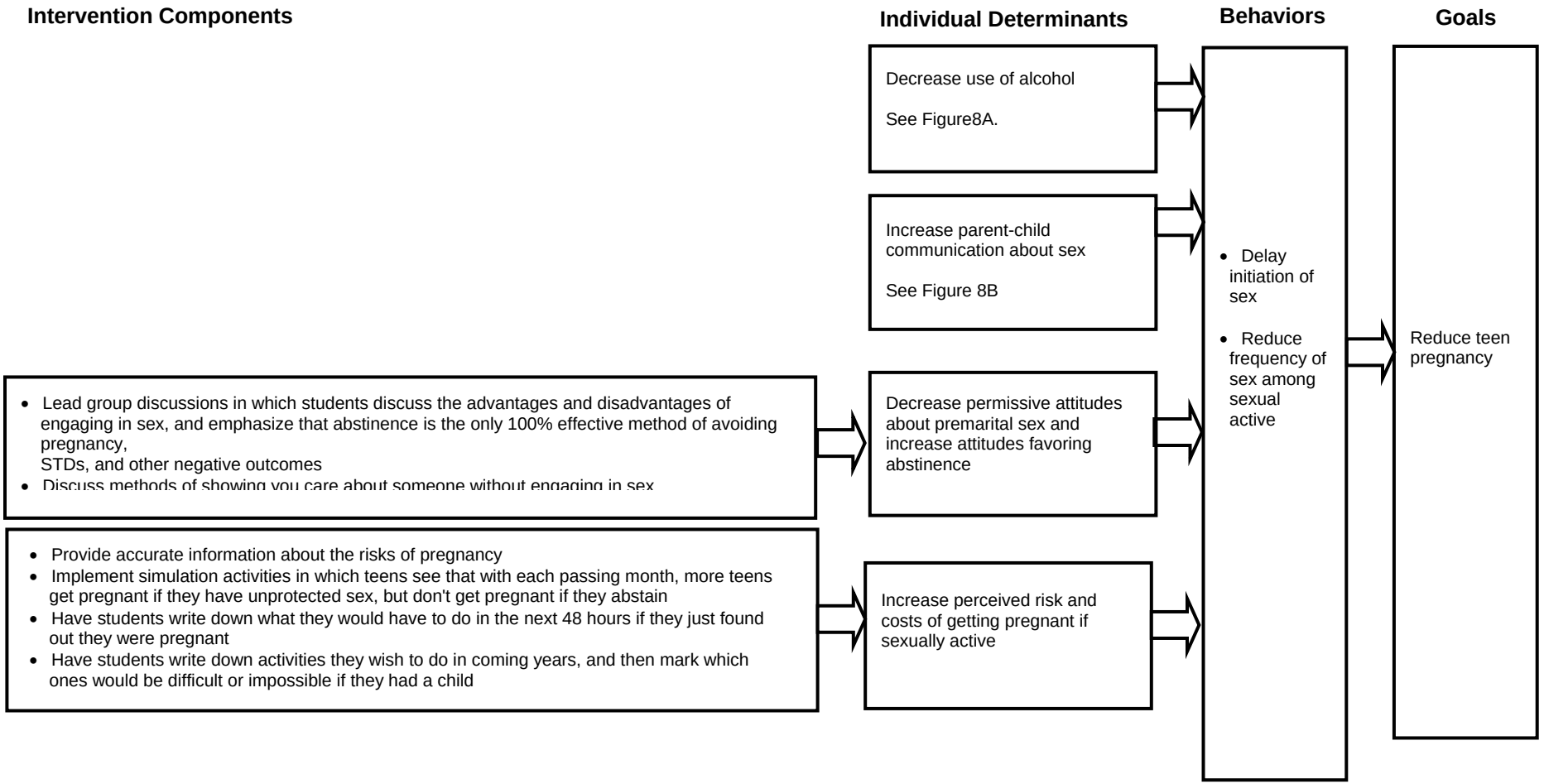


Figure 8:
An Example of a "Nested" BDI Logic Model to Reduce Pregnancy By Implementing a School-based Intervention that Addresses Alcohol Use, Parent-Child Communication about Sex and Individual Psychosocial Determinants of Initiation of Sex



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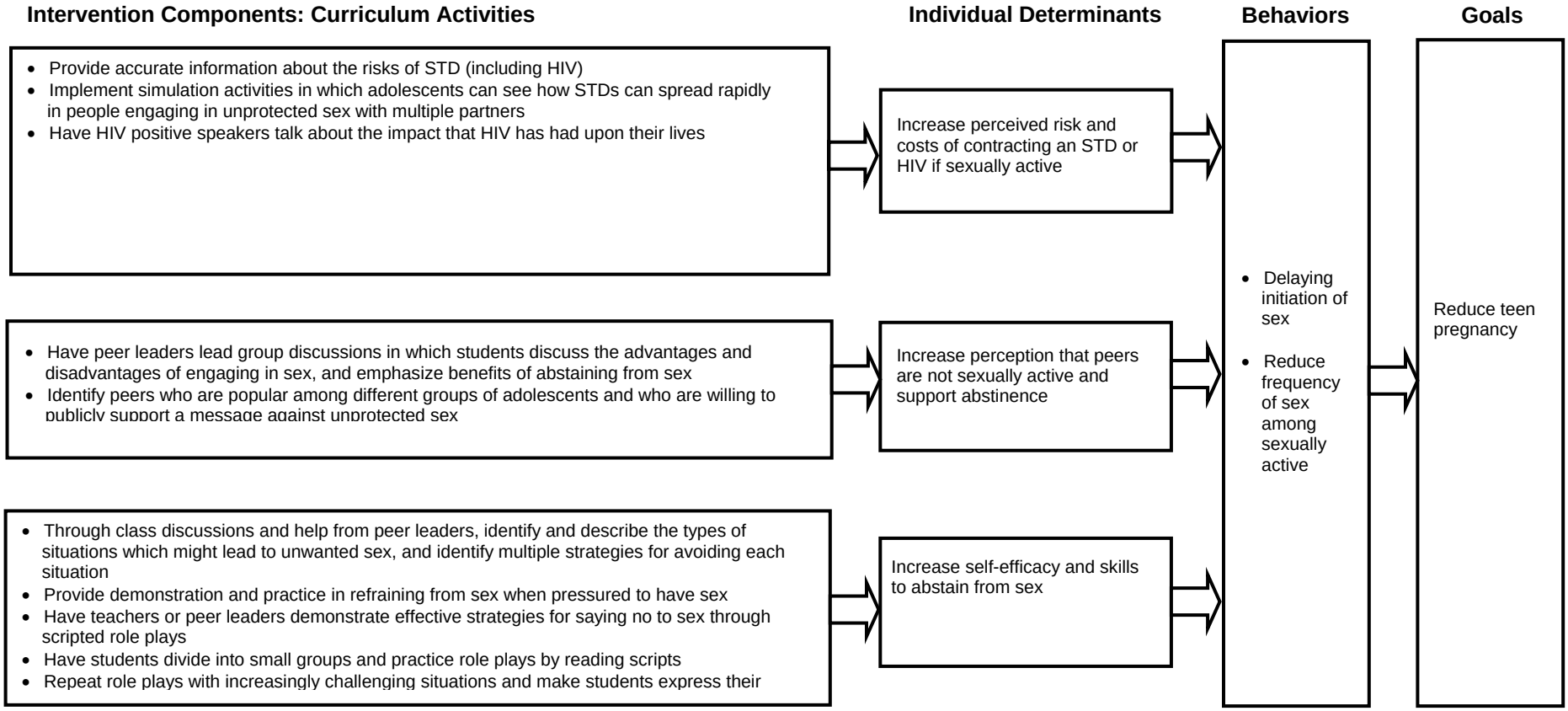

Figure 8A:
An Example of a Model Nested Within Figure 8: A Model to Decrease Use of Alcohol

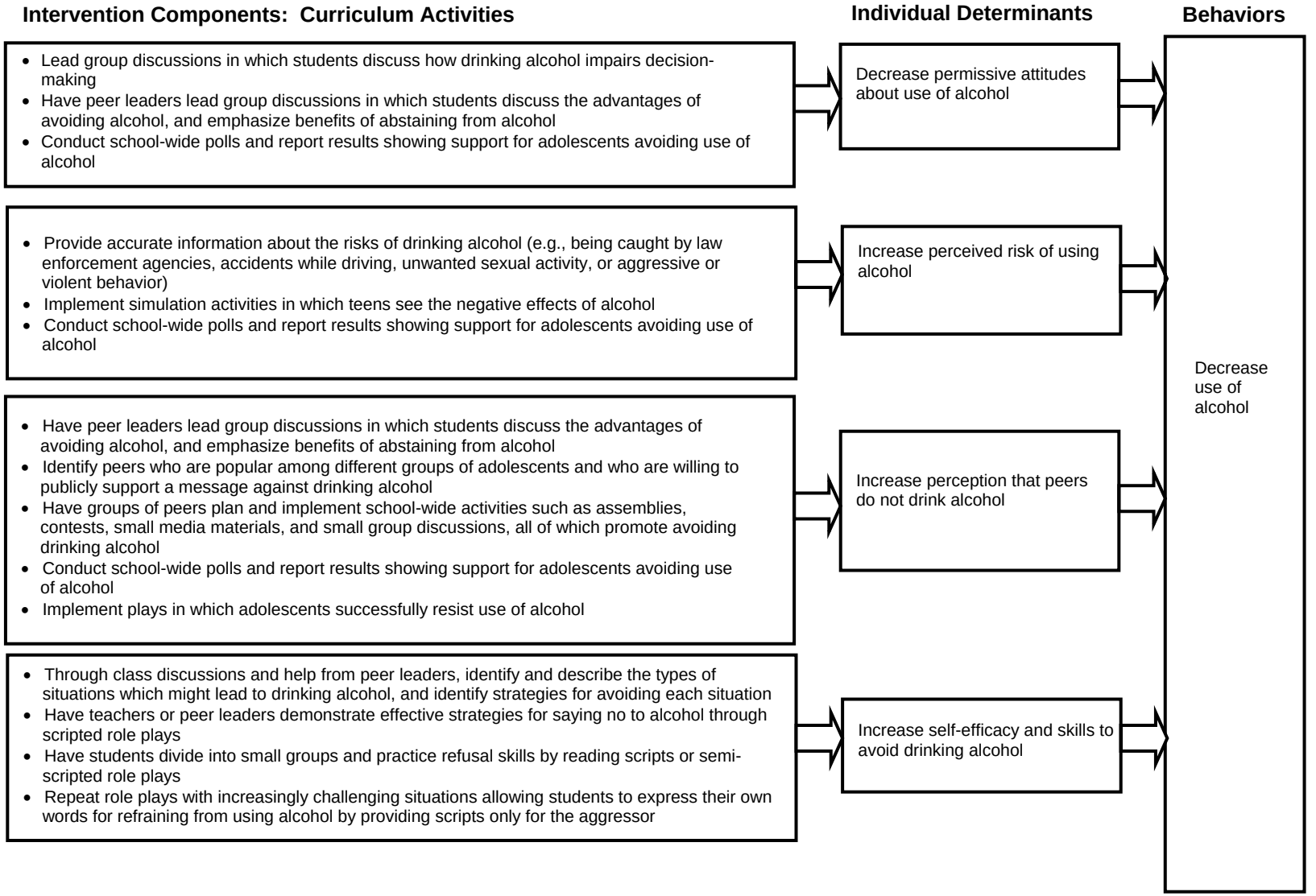

Figure 8B:
An Example of a Model Nested Within Figure 8: A Model to Increase Parent-Child Communication about Sex

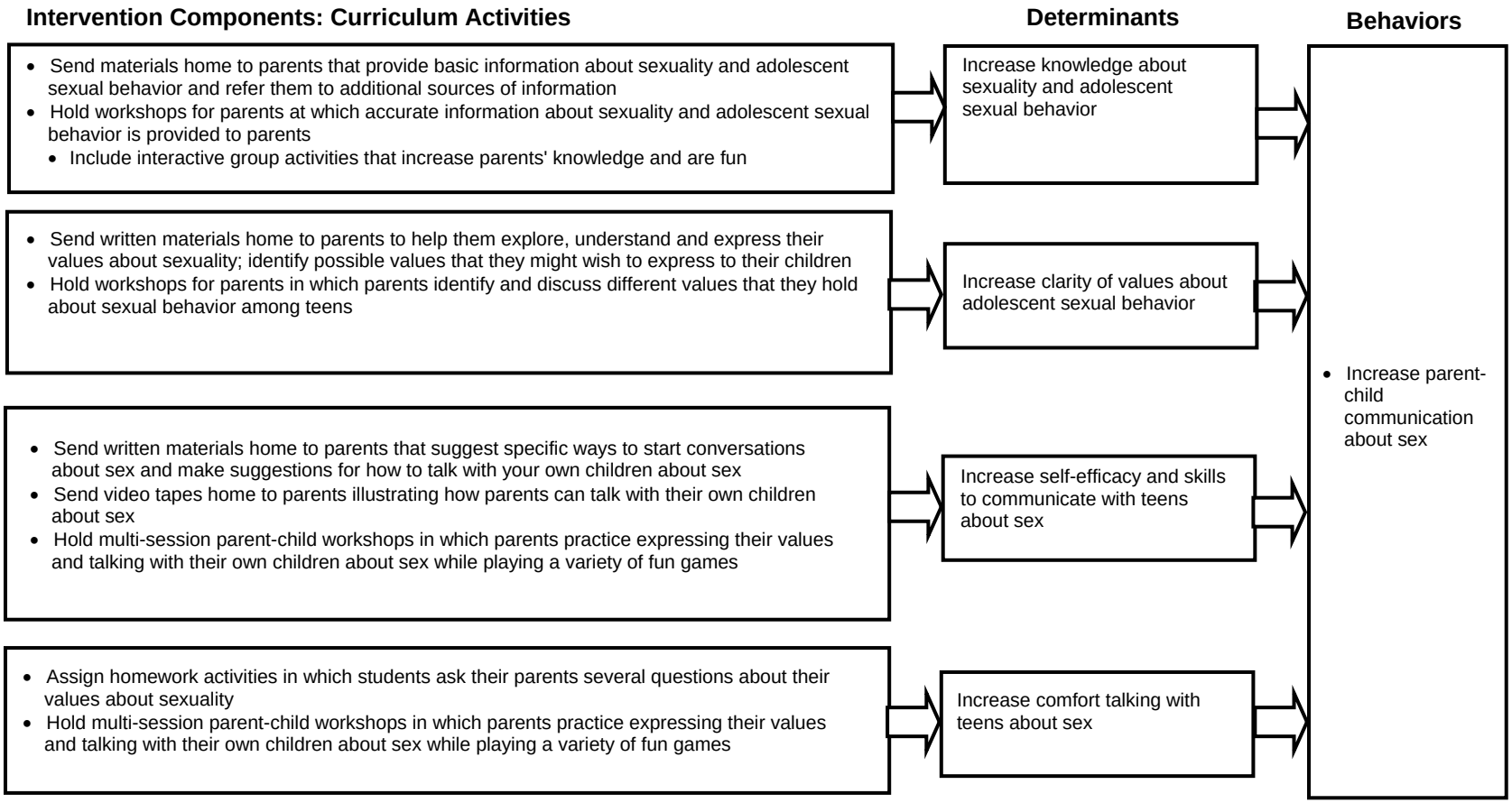

Figure 9:

Criteria for Assessing Logic Models and Their Development

Criteria for Assessing the Model

Overall

- Does the model make sense? Does it reflect the understanding of the group?
- Are all items in the correct column?
- Are all the relationships causal (as opposed to correlational)?

Goals

- Is the stated goal a priority?
- Is it well defined?
- Are the populations well enough defined (e.g., by age, sex, income level, location)?

Behaviors

- Are all the important and relevant behaviors that have a marked impact upon the health goal identified and selected? If not, are there good reasons provided for excluding some of the behaviors?
- Are the behaviors defined sufficiently precisely?
- Do they directly affect the health goal?
- Are they strongly related to the health goal?
- Are they measurable?

Determinants (Risk and Protective Factors)

- Were determinants in different domains identified (e.g., media, community, family, peer, and individual)?
- Are both risk and protective factors included?
- Do selected factors have a strong causal impact upon one or more behaviors?
  - What is the strength of the evidence provided for their causal impact?
- Can the selected determinants be modified markedly by potential interventions?
- Are all determinants that affect behavior and can be changed by feasible interventions included?

Program Components

- Can the activities and components in combination have a marked impact upon each of the selected determinants? Do multiple activities or components address each determinant?
- What is the strength of the evidence that the components can improve the determinants?
- Is it feasible to implement each of the components? Are the necessary organizational requirements in place? Do staff have the needed skills? Are there sufficient financial resources? Is there necessary political or policy support?
- Given the purposes of the model, were the intervention components described in sufficient detail?

Criteria for Assessing the Development of the Model

- Were people with different views involved in the development of the model? Were youth involved in the development of the model? Were people with program experience involved? Were researchers involved?
- Is a process described for actually using the model once it is developed?
- Is a process described for periodically assessing and updating the model?