Understanding Social Determinants from the Ground Up[1]

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Abstract

Social determinants of health explain significant variations in public health and represent potentially important leverage points for community mobilization and social action. Social determinant variables and their causal relationships can be highly subjective and context-specific, and thereby add to the overall dynamic complexity of a system. Group model building (GMB) is one approach to understanding social determinants by including otherwise marginalized voices in the modeling process. GMB can potentially increase mobilization and social action, and lead to better models. How this claim happens is often unclear and confounded by the fact that GMB is itself a dynamically complex system. This paper presents a theory of GMB in the form of a system dynamics simulation model. Results illustrate the relative importance of modeler expertise, initial problem selection, and participation. Implications for future research and practice are discussed with specific attention to the design of community based group model building projects.

Keywords: social determinants, group model building

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Social determinants of health have long been of interest to researchers and practitioners of public health. Most of the indicators that have become the purview of modern social epidemiology and social determinants research are an integral part of the public health approach, and equitably applied public health solutions are touted as the great successes of the field. And yet, social determinants are often addressed by public health researchers as being outside of the realm of normal interventions or etiologically uncertain—treated as largely exogenous variables—with little if any recognition of potential underlying structural differences from one community to the next.

System dynamics has great potential to make a significant contribution to the understanding of social determinants and how social determinants influence health outcomes at the community level. By providing explicit causal theories that view social determinants as a feedback system of its own, system dynamics can help identify and test hypotheses about how and why social determinants persist and affect health outcomes over time.

In this paper, we argue that to achieve better understanding of social determinants, we need to involve communities in the modeling process using participatory methods from group model building. Over the last five years, we have developed an approach through numerous community-based projects and research that suggest that not only is modeling social determinants possible, but that there are important advantages in doing so.[2] At the center of our approach has been a tacit theory about a dynamic relationship between the quality of a model, participation by community members, and perceived relevance of the model to stakeholders. Within the last 18 months, we have sought to make this theory explicit and testable as part of our methodology. This paper reports on the results of this research and its initial application to understanding social determinants of obesity and cancer at the community level.

We have organized the paper into four major sections. In Section 1, we provide a review of the different definitions of the term 'social determinants' along with variables commonly associated with its use and measurement. This sets the stage for Section 2, in which we lay out the main assumptions underlying our approach and how we see it working. We then proceed to test our emerging theory in Section 3 by presenting the results from a system dynamics simulation model of the modeling process as we currently see it, with specific attention to representing the dynamic relationship between the quality of the model and participation of stakeholders. Using what we have learned from the modeling in Section 4, we compare our theory to two sets of modeling projects that have been influenced by our methods' development over the last five years.

Much like a business might use system dynamics to design a supply chain or a factory might use system dynamics to address production problems, we use system dynamics to understand and improve our social research methods. With a focus on methodology, the overarching goal of this discussion is to consolidate the different streams of our day-to-day reflections on how to improve the modeling of social determinants and advance the understanding of when and why it makes sense to work with communities.

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[2] Formative efforts in this approach were developed in collaboration with the Missouri Transformation Project; Foundation for Ecological Security (FES) in India; and, Special Community Workgroup in the West End Neighborhood in St. Louis, MO.

1. Studying Social Determinants

Geoffrey Rose refers to social determinants as "the causes of causes" (1985). However, social determinants are rarely defined explicitly, even in documents such as the World Heatlh Organization's (WHO) *The Solid Facts* (2008), which is designed to be a policy guidebook on the field. Michael Marmot, the editor of *Social Facts* and one of the founders of modern social epidemiology defines social determinants as the gradient in health outcomes according to the social gradient. That is, according to one's position on any number of metrics, life expectancy is longer (for those at the top) or shorter (for those at the bottom). These patterns are robust and persistent for a variety of constructs used to define the social determinants. The WHO itself defines social determinants of health as:

> *The conditions in which people are born, grow, live, work and age, including the health system. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels, which are themselves influenced by policy choices. The social determinants of health are mostly responsible for health inequities - the unfair and avoidable differences in health status seen within and between countries. (World Health Organization 2008)*

Meanwhile, Link and Phelan (1995) provide an overview of the distinction between individual risk and reduction of risk at the societal level without actually using or defining 'social determinants':

> *Medical sociologists and social epidemiologists need to contextualize by asking under what social conditions individual risk factors lead to disease and whether there are any social conditions under which the individual-level risk factors would have no effect at all on disease outcome…Without an understanding of the context that leads to risk, the responsibility for reducing the risk is left with the individual, and nothing is done to alter the more fundamental factors that put people at risk of risks. (p. 85)*

Nancy Kreiger (2001), in her glossary of social epidemiology, defines social determinants as follows:

> *Social determinants of health refer to both specific features of and pathways by which societal conditions affect health and that potentially can be altered by informed action. As determinants, these social processes and conditions are conceptualized as "essential factors" that "set certain limits or exert pressures", albeit without necessarily being "deterministic" in the sense of "fatalistic determinism".*
>
> *Historically contingent, social determinants of health, broadly writ, include: (a) a society's past and present economic, political, and legal systems, its material and technological resources, and its adherence to norms and practices consistent with international human rights norms and standards; and (b) its external political and economic relationships to other countries, as implemented through interactions among governments, international political and economic organizations (for example, United Nations, World Bank, International Monetary Fund), and non-governmental organizations. (pp. 697-698)*

In the CDC's guidebook, *Promoting Health Equity: A Resource to Help Communities Address Social Determinants of Health* (Brennan Ramirez, Baker, and Metzler 2008), Sherman James' definition is quoted:

> *Social determinants of health are life enhancing resources, such as food supply, housing, economic and social relationships, transportation, education and health care, whose distribution across populations effectively determines length and quality of life. (p. 6)*

While the definitions vary, all emphasize social determinants as social factors influencing disease and health outcomes where 'social' refers to both non-biological and societal realms, as opposed to the individual. Moreover, social determinants reflect that there are obvious connections between the social conditions that marginalized people live in and health outcomes that are not explained by appealing to individual health behavior and biology. Hence, there is the sense that understanding social determinants is more than just descriptive in nature, but also political and normative in seeking to redress social injustices. Put differently, understanding social determinants is about understanding variations and differences *associated with marginalized communities*.

Another way to consider how social determinants are defined in research and practice is to examine the variables falling under the category of social determinants. Table 1 lists the variables used to illustrate social determinants for different authors. While some variables such as transportation, unemployment, and working conditions cut across most authors' conceptualization of social determinants, many do not. These appear more indicative of individual conditions than social conditions. For example, with the potential exception of the variable "addiction" in the WHO list (if one takes a disease-oriented approach to addiction), it is noticeable in Table 1 that most if not all individual conditions involve a strong element of socially constructed disparities.

When we talk about social determinants such as access to water, we already know that access to clean water is essential for public health (biological fact), so we are interested in understanding why some people have access to clean water and others do not (a social fact). More importantly, we are interested in why such a social fact persists against moral sensibilities and commitments to basic human rights. To explore this, we need to move beyond simply describing communities with proxy variables and associated outcomes, and instead assess *how* social conditions affect people, and in turn, how people respond to their social conditions and attempt to manage and resist their impact. Simply relying on a set of indicators such as poverty, crime, housing prices, or segregation is not enough. We need to understand the underlying structure, ideally from the members of the community, in order to adequately grasp the causal relations between people, their environment, and health outcomes.

If we take this task seriously, a second review of Table 1 highlights that, in trying to understand the underlying causes of social determinants, the insidious nature of social determinants becomes apparent. Many of the causes of social determinants are other social determinants. Thus, social determinants represent a distinct and self-sustaining feedback system. Once in motion, the relationship is self-reinforcing to the point that the ultimate balancing loops become mortality and migration. Developing this hypothesis more fully in a way that is testable requires further evolution of a theory of how social determinants persist and influence various health outcomes (e.g., obesity, cancer).

Table 1: Social determinants variables

WHO (2008)	**Kawachi & Berkman (2000)**	**Dahlgren & Whitehead (1993)**	**Anderson et al (2003)**	**Colorado Department of Public Health**
• Stress • Early life • Social exclusion • Working conditions • Unemployment • Social support • Addiction • Healthy food • Transportation	• Discrimination • Socioeconomic position • Income inequality • Working conditions • Unemployment • Social integration/social capital • Physical/social environment	• Education • Work environment • Unemployment • Water and sanitation • Agriculture and food production • Health care services • Housing	• Neighborhood living conditions • Opportunities for learning and developing capacity • Community development and employment opportunities • Prevailing community norms, customs, and processes • Health promotion, disease and injury prevention, and health care opportunities	• Adequate income • Educational attainment • Quality of housing • Quality of schools • Access to recreational facilities • Transportation resources • Access to healthcare • Clean and safe environment • Participation • Social network/social support • Leadership • Political influence • Organizational networks • Racism

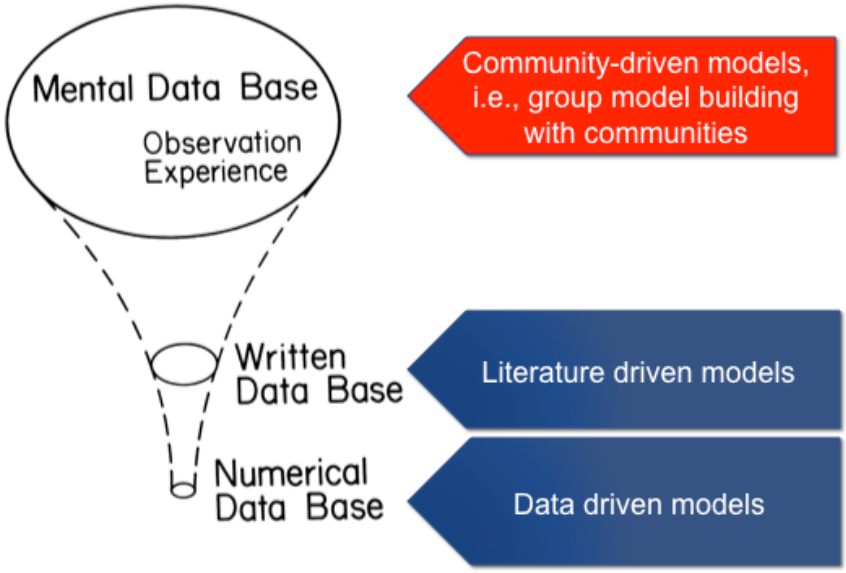
System dynamics has a clear role to play in understanding agency-structure issues and developing social theory (e.g, Lane 2001, 2001; Schwaninger and Grösser 2008). Building a model of social determinants, however, requires one to identify the very social relations that are creating the social determinants in the first place (Harding 1991). In particular, it requires being able to adjust for the way that social relations such as power differences and oppression, distort perceptions of what is occurring within a community. In system dynamics, this can be done through the use of participatory methods such as group model building (Vennix 1999, 1996; Richardson and Andersen 2008; Luna-Reyes et al. 2006; Andersen and Richardson 1997). However, most group model building (GMB) efforts generally exclude participants from marginalized communities, preferring instead to primarily work with educated professionals (Rouwette, Vennix, and Mullekom 2006). More recent efforts building on structured group model building using "scripts", show promise in working directly with marginalized communities in diverse contexts and with a wide variety of problems related to social determinants (Hovmand et al. 2012; Hovmand, Brennan, and Chalise 2011).

2. Four Assumptions in Working with Communities

Working directly with communities to understand social determinants draws on four basic ideas. First, that community members already have the rich information available needed to build a system dynamics model, whereas any effort to rely only the literature or a numeric database will be limited by comparison. Forrester (1980) noted this point over 30 years ago when

talking about the development of a model of the national economy. Despite the proliferation of information technology, databases, and advanced geographic information systems and network analysis for visualizing these data, the data collected is still limited to a relatively small set of variables. By comparison, the very nature of marginalization involved with social determinants means that often no data are being collected and available. Group model building therefore taps into the communities' rich mental database (see Figure 1).

Figure 1: Information sources in community driven models, adapted from Forrester (1980)



Second, community members are much more likely to quickly identify the proximate variables that impact their health and relevant causal mechanisms. The value of participants being able to identify variables, trends, and structure as they experience social determinants becomes invaluable when considering that the relationship between social determinants and the underlying structure has the potential to be heterogeneous across communities as well as across time and health outcomes over time. If one is going to attempt to comprehend social relations and understand social determinants, then understanding participants' perspective is a vital place to start.

Third, while participants' can readily share their perceptions of social determinants, this ability does not in itself translate into an objective view of the system. There are many ways that information from community members can be biased and distorted, not the least of which is basic cognitive limitation placed on our mental models (Sterman 2000). Simply transcribing and aggregating information will not only introduce errors, but could easily reinforce flawed mental models and attribution errors in a community. It is critical to understand that any outsider enters the situation with the same types of limitations. Moreover, one cannot avoid this problem by trying to draw a neat distinction between scientific knowledge and other types of knowledge for the scientist relies heavily on their own mental models to formulate and test hypotheses, and in most cases, these are not specified as mathematical and hence logically testable models.

This is not to dismiss all scientific knowledge, but a research database that is heavily reliant on linear cause-effect models to the exclusion of feedback relationships is going to be restricting when trying to grasp complex systems underlying social determinants. What is needed are better

mathematical specification of feedback theories that can be tested and developed (Meehl 1990) that support better measurement and study. In our experience, most communities in the world can readily engage in this process with appropriate facilitation to develop better model specification.

Fourth, recognizing that building a theory of social determinants is both a developmental process and iterative process, the insights gained need to be co-developed with the community. An expert modeler, for example, may quickly see the underlying generic structure of a system, reach a diagnosis, and make a recommendation for action. But, to the extent that this recommendation is at odds with the conventional wisdom in a community, it is likely to not only be rejected and not implemented, but to generate political resistance to the modeler's methods. At the most extreme, it is a fixation of the outside expert on being right at the expense of recognizing that it is the community that must ultimately act to change the system and deal with the consequences. In many communities, this type of modeler attitude is perceived as another attempt at colonization and oppression. It is essential to understand the problem here is not about whether the expert is right or wrong, but the relationship of the expert to the community around knowledge.

In summary, people need to be a part of the process of developing models of the social determinants they experience if the results are going to be accepted within the community and implemented. More precisely, to build models of social determinants, communities need to be engaged in a way that allows for participants to discover and self-correct the model that is being developed. Hence, engagement in this sense is not a one-time involvement, but necessarily occurs over time. What this means, how to implement it, and why it might work are the focus of the next section.

3. Simulation Model

To test the dynamic hypothesis that community engagement can improve the quality of modeling as we described in the previous section, we developed a relatively simple system dynamics simulation model shown in Figure 2.[3] The model has two main stocks. The quality of the model ranges from 0 (lowest quality) to 100 (highest quality), and participation represents the number of people involved in the modeling process.

The process of building a model is conceptualized as improving some model relative to some information inputs. The inputs to a modeling process are viewed as two types of information: (1) data about structure, behavior modes, parameter estimates, etc.), and the relevance of that information to the problem at hand, and (2) relevance of that data to the problem at hand. The process of building a model is then viewed as the modeling comparing the current information inputs (data and relevance) against the current model, and responding to discrepancies between the two by seeking to improve the model. Modeler skill is conceptualized as how well the modeler responds to this discrepancy, and ranges from 0 to + ∞ with the "average competent modeler" having a value of 1. The average competent modeler will respond to this discrepancy with an average adjustment time. An expert modeler with a value of 10 will be able to compensate for low quality information and work more quickly than the average competent modeler. An inexperienced modeler just learning system dynamics might have a value between 0

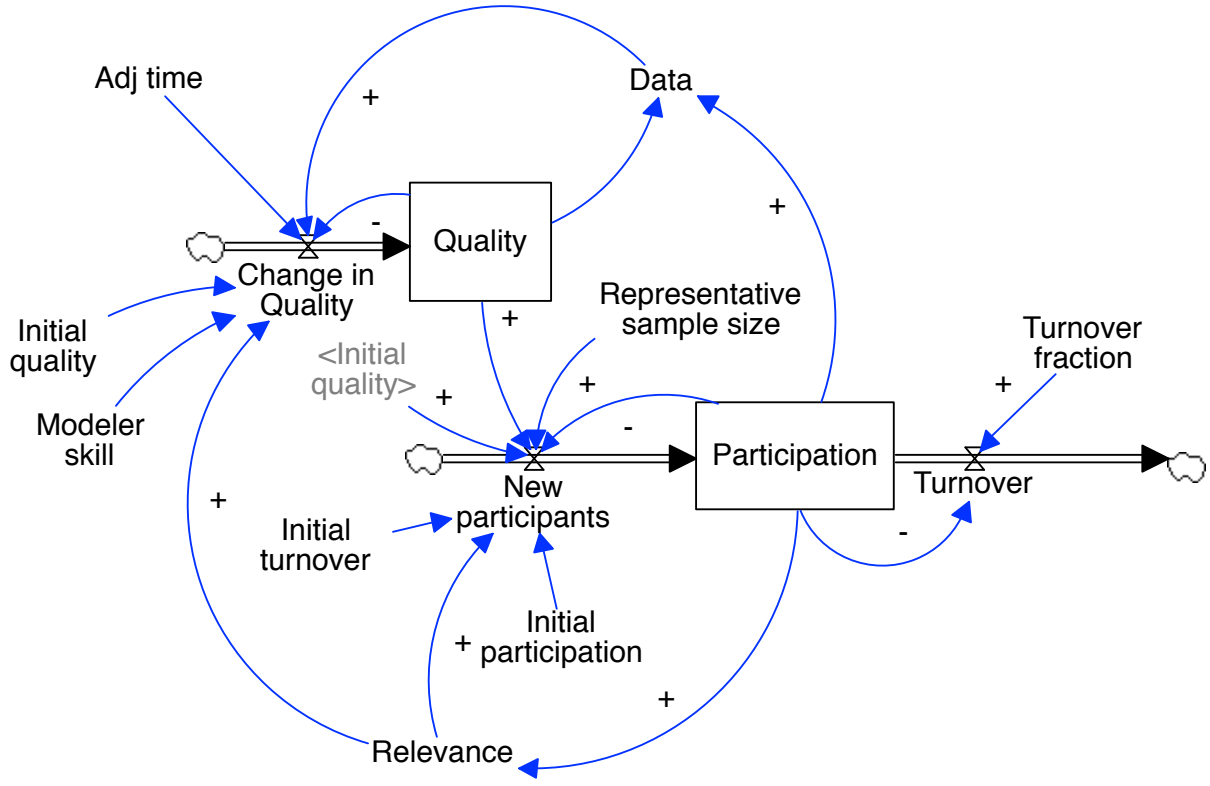
[3] The model runs on Vensim PLE, but can readily be reconstructed in other simulation packages. Anyone interested in the model and equations should contact the first author for the latest version.

and 1, and an "incompetent modeler" having a skill value of 0 meaning that they would never, regardless of how good the information inputs, be able to improve the model.

The quality of the data represents has a value from 0 to 1 and reflects how good the content is in terms how much data there is, how well the data is measured, and how well the data is understood. Quality of data is a function of the number of participants and the quality of the current model as it is assumed that the current model is used to identify and interpret data. A low quality model will make it more difficult to identify, collect, and use data provided by a community even if there is high participation. Conversely, having a great model with little participation from participants will yield low quality data.

Relevance represents a second dimension of the information used to build a model. Relevance is the degree to which the data being collected is relevant to the problem at hand, and ranges from 0 to 1. For simplicity, relevance is seen as being directly proportional to the number of participants relative to a representative sample size. The notion here is that for a given problem, there is some minimum number of people who would need to be involved in order to have adequate representation of different views. This could be a statistically representative sample, but the nature of modeling and systems means that more of than not, it is more about having participants who are knowledgeable about the relevant structures in a system. The specific dimensions (e.g., demographics, life history, status in the community, decision-making role, experience, influence, etc.) that are relevant will vary by the nature of the problem and type(s) of marginalization.

Figure 2. Model of participation and quality of modeling



Models that have low participation rates are likely to focus on a priori assumptions about the problem and not be challenged by related or entirely different problem formulations. This assumes, of course, that the quality of participation is high and problems such as "group think" or having a minority of individuals dominate the conversation have been avoided through effective design and planning of the group model building session. Hence, the role of effective facilitation is essential (Vennix 1996, 1999).

A number of factors influence new participants in modeling. High quality models are more likely to generate interest and increase participant recruitment. The relevance of the information in a model and hence its face validity to participants is also important. Participants are more likely to engage in a community modeling session if the model is seen as relevant to their situation. The model also includes participant turnover, which is normal during projects with extended engagements of more than a few months due to changes in schedules, family and work commitments, etc. Initial participation represents the number of people initially involved at the start of a project (e.g., the first group model building session).

To better understand and test the dynamic theory of participation and model quality, we considered four scenarios of initial participation (50%, 60%, 70% and 80% of the representative sample size) assuming an expert modeler (value of 10) with an average initial quality model at the start of the project (value of 50). Figure 3 shows the results from the scenarios and highlights the sensitivity of the project outcomes to initial levels of participation. For the 50% and 60% scenarios, the quality of the model *declined* over time and ultimately failed, while the 70% and 80% scenarios showed the quality of the modeling project *increasing* over time and ultimately representing a success. The explanation is that the initial participation in the modeling for the 50% and 60% scenarios is too low to get a virtuous modeling cycle going leading to both declining relevance and declining quality of data. As relevance and data quality decline, the quality of the model declines even further, and this results in a vicious cycle of declining quality, participation, and relevance.

Figure 3. Comparison of quality over time for four simulated projects with initial participation at 50%, 60%, 70%, and 80% representation of stakeholders. Initial skill of modeler is 10 and initial quality of model is 50.

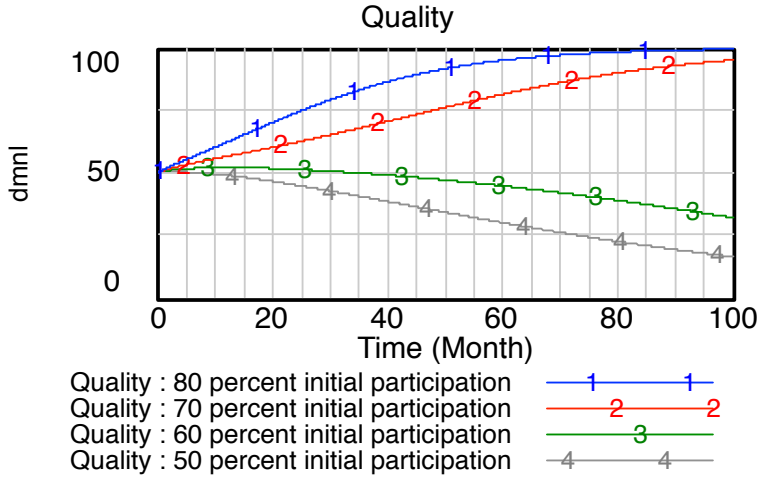
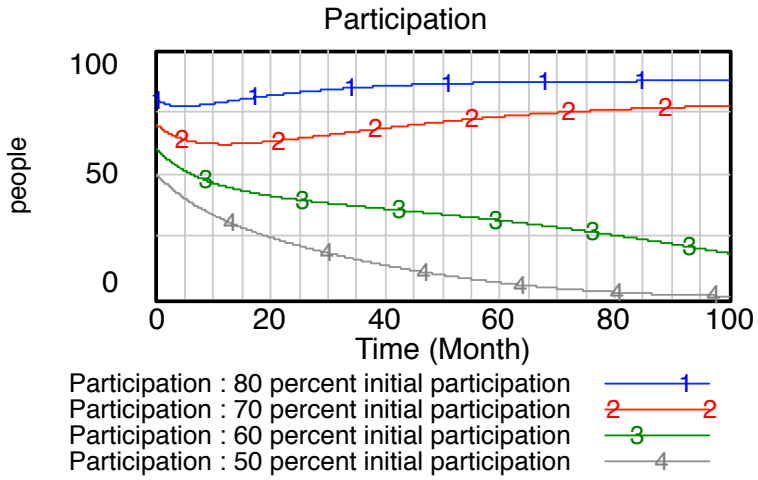


Figure 4. Comparison of participation over for three simulated projects with initial participation at 50%, 60%, 70%, and 80% representation of stakeholders. Initial skill of modeler is 10 and initial quality of model is 50.



The next question we considered with the model was how sensitive the eventual quality of the model was to initial participation, initial quality of the model, and modeler skill. To answer this, we varied initial participation and initial quality of the model from 10 to 90, and modeler skills from 0 to 10. Figure 5 shows the result with the final quality of the model plotted on the y-axis and the modeler skill on the x-axis. The green bars show initial quality and the pink bars show the initial participation. The blue points indicate the quality of the model at the end of the simulation run. There are 8181 observations in Figure 5, so the plots of the blue points appear smooth, but are in fact, overlapping individual runs.

Looking at the graphs in the upper right hand of the Figure 5, it is clear that there is a relationship between modeler skill and final quality of the model with greater modeler skill increasing the final quality of the model. However, this relationship is clearly not uniform. If one looks down the right most columns where initial participation is high but initial quality is decreasing as one moves down the columns, and compares this with the top two columns moving from right to left where initial quality is high and initial participation decreases, then one can see that initial participation has the largest effect followed by initial model quality and finally by modeler skill.

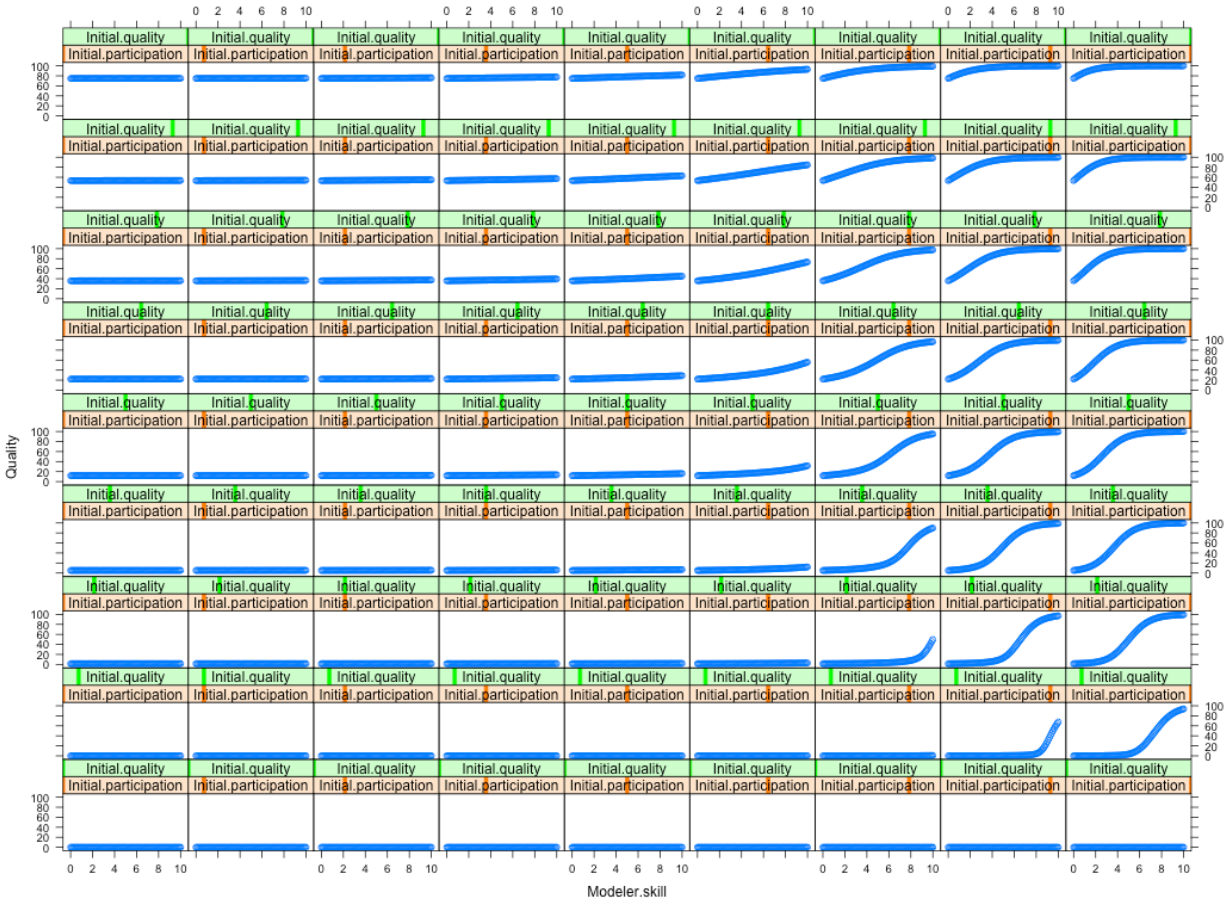
Overall, the model results support the general feasibility and potential importance of participation in the process of modeling social determinants. The results also highlight the relative importance of participation, initial quality, and modeler skill. Also important to note is that a strategy of starting with a few people and building up participation would not work according to these results. Low initial participation contributed to low relevance and quickly dissuaded people from joining the project, which was made worse by the declining quality of data.

In practice, this can occur as a result of a poorly chosen model as a starting place and not taking the time to initially understand and scope out the problem.[4] This can also happen when the initial participants do not, in fact, have representative knowledge of the community; for

[4] Robinson (1980) notes that Forrester would typically spend extensive time to understand and scope out a problem before building a model.

example, if one is working with leaders in a community-based organization that is largely distrusted by the community with which one is interested in collaborating.

Figure 5. Final quality of model (y-axis) as a function of initial quality (green), initial participation (pink), and modeler skill (x-axis)



4. Comparing Theory Against Two Cases

We now compare the theory against what happened in two separate projects, both of which incorporated principles developed in this research into the design of group model building projects. The first project is a study to understand the social determinants of health. Over the last two years, the project has engaged a low-income, predominately African American community to understand the social determinants of childhood obesity. The community has many challenges, including high prevalence of gangs and crime, absence of schools in the neighborhood, no grocery stores, and substantial marginalization relative to other neighborhoods in the community. Through a series of community meetings, the research team introduced various concepts of system dynamics to community members and gradually developed the sophistication of these methods.

Several themes emerged through this process, but perhaps the most illustrative of this approach are insights that emerged around the topic of corner stores. Corner stores are small

"mom and pop" stores typically found in low-income neighborhoods. Lacking distribution systems, corner stores rely on other grocery stores as their main suppliers and typically generate a profit by selling unhealthy items such as alcohol, tobacco, and unhealthy snacks. They are often implicated in the discourse on childhood obesity as the primary food source in a low-income neighborhood, and the prevailing thought is that the primary relationship between the prevalence of corner stores and childhood obesity is about access to food.

However a different interpretation resulted from a group model building exercise designed by a high school student from the community. One of the themes that emerged from the structure elicitation exercise was that corner stores were places where younger children felt safe and older children became involved in gangs through initiations such as fights and shoplifting. Gangs in this particular study neighborhood are a major problem and prevent residents from using playgrounds, taking walks, and general socialization. Yet it was only through this exercise that we came to understand the role of corner grocery stores in the social reproduction of gangs within the neighborhood. This explanation represents a narrative that is fundamentally different from the prevailing ideas regarding the primary function of corner stores as a food source in a neighborhood. This highlights how different the explanations can be for a particular variable, and the importance of involving participants in the design of participatory sessions to unearth alternative explanations.

In the second example, we focus on a series of projects in primary and secondary public education where we have engaged a local high school on a variety of topics from school safety to educational achievement and outcomes. Each project started with an assumption that there was a specific problem to be understood separate from other problems. What emerged through this work, however, was a set of common themes about the (hypothesized) underlying causes of school conditions—that is, an underlying generic structure about schools and social determinants. By applying this approach over time and multiple projects within the same community experience with system dynamics and group model building also accumulated. With experience, students also began to take a more active role in the design and facilitation of group model building exercises. While any one individual project in isolation might seem limited in scope and outcomes in comparison to a more typical longer-term engagement with an organization, the ensemble of projects led to more sophisticated and actionable system insights.

What is important to recognize in this second example is that it is not through experts modeling the situation that we gained insights into the role that social determinants played. It was by building participation and capacity in participants through modeling over a series of projects that structure emerged. This does not mean that the expert modeler does not have a role, but the role is different from what one might commonly imagine. The role of the expert modeler is more of a guide or coach on modeling, as opposed to the person doing the modeling. The ultimate goal is still the same, but in viewing group model building as a developmental process over time through a series of projects, how it is done is fundamentally different. To develop a good model of social determinants, one initially forgoes modeling expertise and focuses on building participation, *and then* works with the community to improve the initial model over time.

We did not model analyze a series of modeling projects, but this second example suggests a promising way of how one can build up participation and the quality of the initial model. More specifically, if participation and quality of the initial model play such a dominant role in the end result, then one must consider strategies that develop these initial conditions. This

places much greater emphasis on our fourth assumption—that the modeling process is iterative and developmental—and hence needs to be studied and managed effectively along those lines.

5. Conclusion

In this paper, we have argued that to understand social determinants of health, one needs to involve communities directly in the modeling process through group model building in order to address specific types of epistemological limitations, namely: (1) marginalization creating a scarcity of data where one needs information to build models, and (2) biases that arise from power differences associated with marginalization. We have not taken the position, however, that it is obvious or should be taken as a matter of fact that the products from participation are inherently superior from a scientific perspective than a more traditional expert driven modeling process. Instead, we have argued that there is a way to involve participants, which over time and through multiple engagements, yields a result that could not have been achieved through a traditional expert driven approach.

This approach is based on a combination of our own experience, modeling, and reflection. What we have learned and grown to appreciate more deeply by making the process more explicit and testable in the form of a simulation model is how essential the role of meaningful participation may be to the overall outcome. The conclusion that we have ultimately arrived at is that to build a good system dynamics model of social determinants, we need relinquish expectations that the expert modeler is building the model, and recognize that the greatest role for the expert modeler may be in designing and facilitating a process over time that helps participants with little or no skill in system dynamics develop their own novice skills, identify starting points, and invite their friends and neighbors into a modeling project.

This is not to say that the role of modeling expertise is unimportant or irrelevant when considering social determinants—quite the contrary. Modeling expertise, participation, and the starting point of a model are all essential components of a successful project. The role of modeling expertise is not what we initially thought it was. The role of the expert modeler, then, is not about having a correct answer, but understanding modeling procedures and facilitating a process whereby a community can learn to discover their own answers from the ground up.

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