Using System Dynamics Modeling to Foster Effective School-Based Wellness Program Planning and Implementation

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Innovations in Collaborative Modeling

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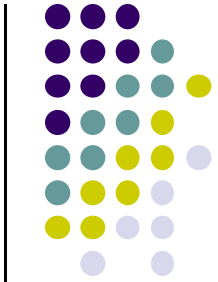
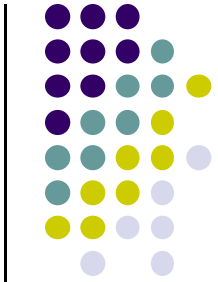
US Now: Obesity and Overweight is Epidemic among Youth



- Childhood obesity has more than *doubled in children* and *quadrupled in adolescents* in the past 30 years
- Obesity prevalence among youth ages 2-19 remained virtually unchanged between 2003-2004 and 2011-2012:
  - 12 million children and adolescents are obese (17%)
  - 23 million are either obese or overweight (32%)
- Some progress for very young children ages 2-5, with decline in obesity prevalence from nearly 14% 2003-2004, to 12% in 2009-2010, to 8% in 2011-2012

Ogden et al., 2014; NCHS, 2011

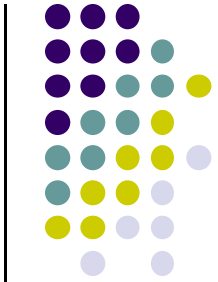
Youth Risk Behavior Surveillance System (YRBSS), NYC Survey



- Based of self-reported height and weight data, 39% of high school students (grades 9-12) were classified as overweight or obese
- 43% reported trying to lose weight
- Approximately 27% indicated they would describe themselves as overweight or obese
- Only 38% of youth in these grade levels are meeting currently recommended 60 min/day physical activity

Heo, unpublished (Source: YRBSS, 2007)

State of the Science: Obesity Prevention Research for Youth



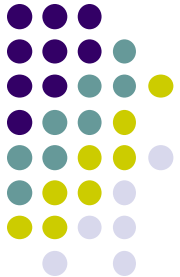
- Physical activity interventions in a school-based setting with a family component **or** diet and physical activity interventions in a school-based setting with home and community components have the most evidence for effectiveness (Wang et al., 2013)
- However, more research is needed in school-based nutrition/diet interventions and in how to effectively implement and sustain interventions in diverse school settings and communities (Frerichs et al., 2015; Jones et al., 2014)

Project Overview

National Institute of Diabetes and Digestive and Kidney Diseases

R01 DK097096

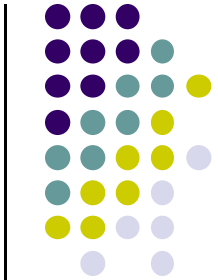
Judith Wylie-Rosett, PI



In partnership with **HealthCorps**, the **Alliance for a Healthier Generation**, and the **NYC DOE Office of School Wellness**, work with NYC high schools to:

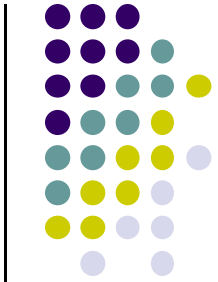
- Introduce, develop and evaluate a *participatory implementation model* to promote effective wellness policies, practices and programs
- Use *system thinking* to engage school wellness champions in effective *action planning* to achieve obesity-related health recommendations, per 2010 US Dietary Guidelines
- Develop *system dynamics models* that support statistical outcomes modeling and that foster post-project *dissemination/scale-up*

Project Design



- Stepped wedge cluster randomized design
  - Year 1: Engage n=2 pilot schools
  - Years 2-4: Roll out testing of the participatory implementation model in n=4 randomly selected NYC HealthCorps high schools
  - Total sample: N=14 schools; N=6,000 students (n=1000 per cluster per year)
- Primary data sources
  - HealthCorps Survey (paper & e-portal; 2 x yr)
  - BMI assessment (measured & self-rep; paper & e-portal; 2 x yr)
  - School Wellness Council key informant interviews and participant observations (as useful, 2plus x yr)
- Secondary data sources
  - NYC DOE FitnessGram and School Progress Report (annual)
  - NYC DOHM School Food Report (monthly)

Project Hypotheses



1. Students will show improvements in achieving *key health behaviors* after their NYC HealthCorps school is randomized to participatory implementation compared to students in the waitlisted HealthCorps control schools
2. Improvements in the key health behaviors will be greater in students whose *BMI z-scores* decrease compare to those whose BMI z-scores did not decrease

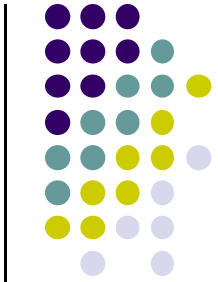
Key Health Behaviors

Promote achievement of goals of the *Healthy, Hunger-Free Kids Act* and the *U.S. Dietary Guidelines*:

1. Decreasing sugary beverage intake
2. Increasing frequency of breakfast
3. Increasing vegetable and fruit intake (2½ cups/day)
4. Decreasing frequency of fast food meals
5. Becoming physically active (1 hour/ day)
6. Reducing sedentary behavior time (<2 hour/day)

Major challenge: How to build skills and sustain student health behavior change?

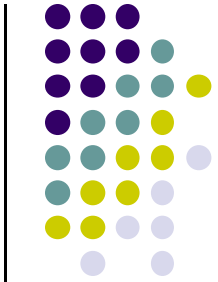
NYC DOE School Wellness Policy Initiatives



The NYC DOE has instituted system-wide wellness policies and programs to address obesity, including:

- Diet: Switching to low-fat milk, Offering free school breakfast, Removing sugary beverages and high fat snacks from school vending machines and sales, providing more fruits and vegetables
- Exercise: Mandatory physical education Physical fitness evaluation (*FitnessGram*), programs *Move-to-Improve*
- Collaborative planning and teaching: School Wellness Council Grant Program and Health Education Leadership Program

NYC DOE School Wellness Councils



- Collaborative planning via *School Wellness Councils* (SWCs) is mandated by the USDA for school districts that receive federal school meal funding
- SWCs operate at the school building or campus level and function in an advisory role to principals
- SWCs are coalitions of diverse stakeholders: Students, educators, administrators, parents, and CBOs
- Council members' objective: Systematically identify and address school building/campus-specific wellness goals

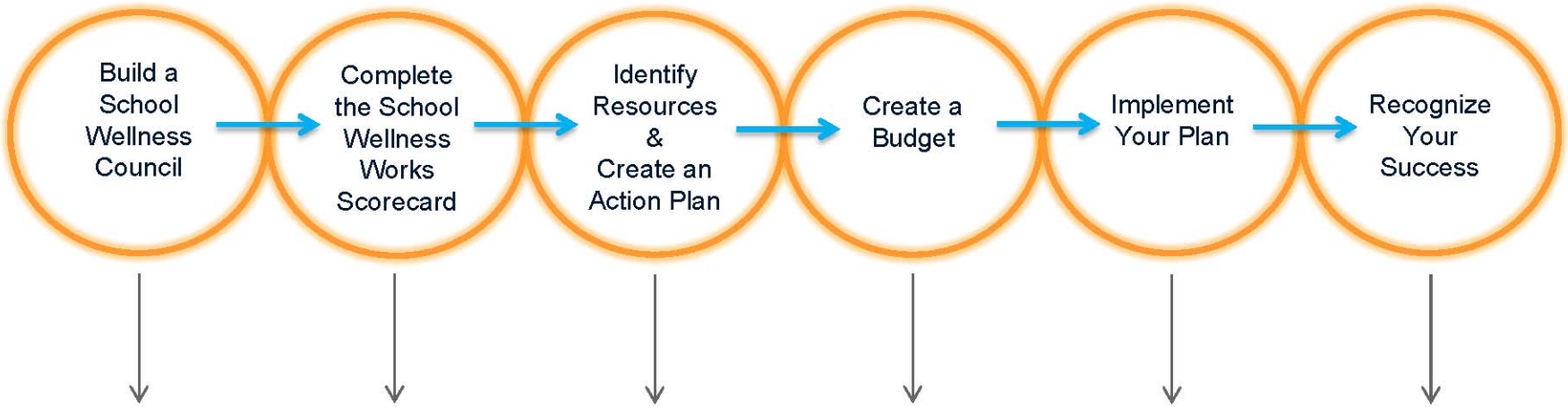
NYC DOE, 2010

The Alliance for a Healthier Generation's 6 Step Process for Building School Wellness

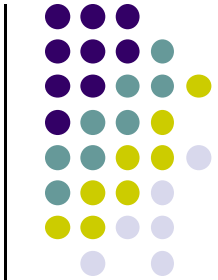
The Alliance's **6 Step Process**, is a web-based evidence-based approach to building and sustaining a school environment that promotes wellness for students, teachers, and staff.

USING THE SCHOOL WELLNESS WORKS PORTAL

Schools can use the School Wellness Portal to manage a school wellness council, consider NYC specific standards and practices around wellness, start an action plan, or peruse wellness resources and guidance. Refer to this Portal User Manual for assistance in completing the steps below.

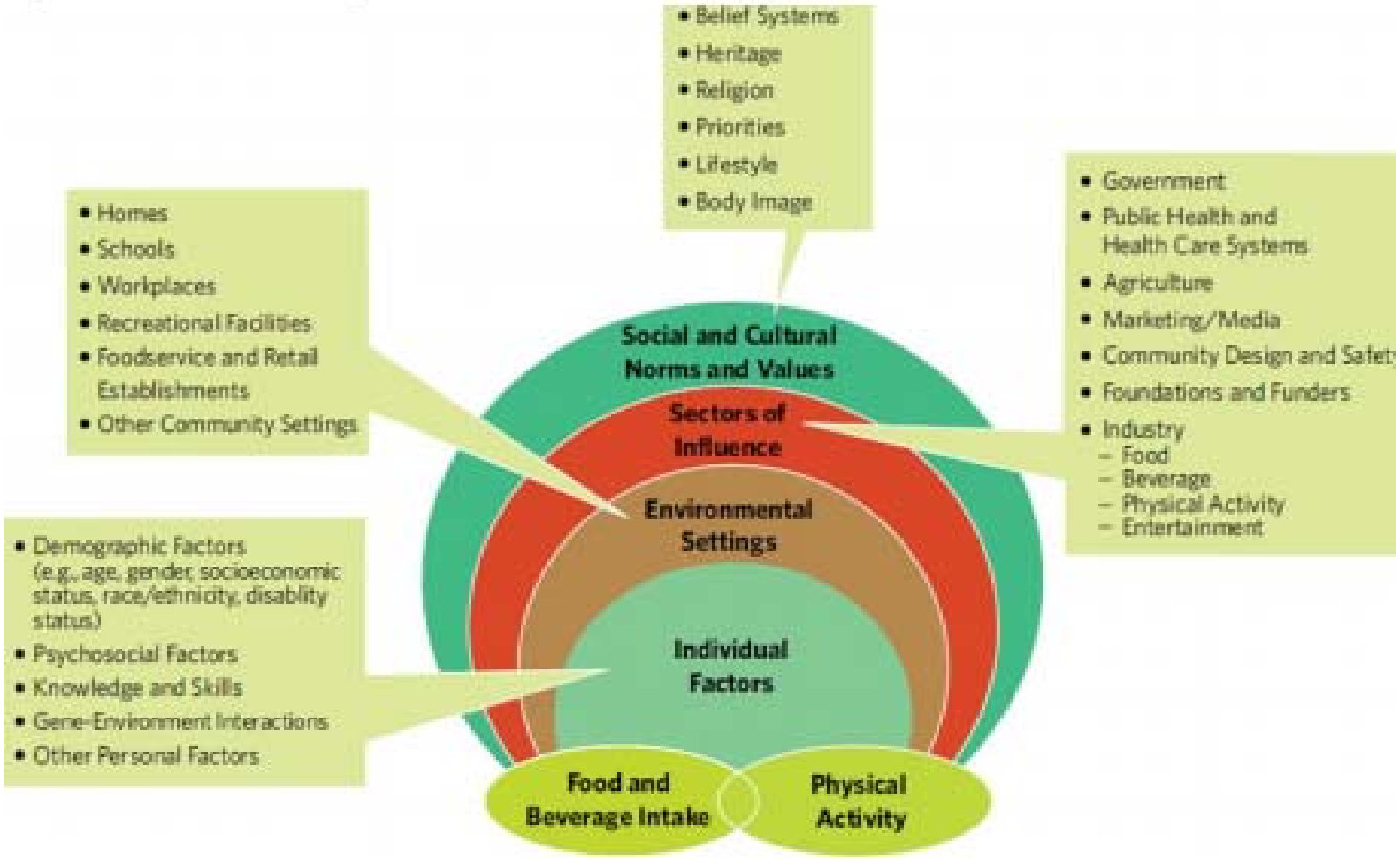


Research Propositions



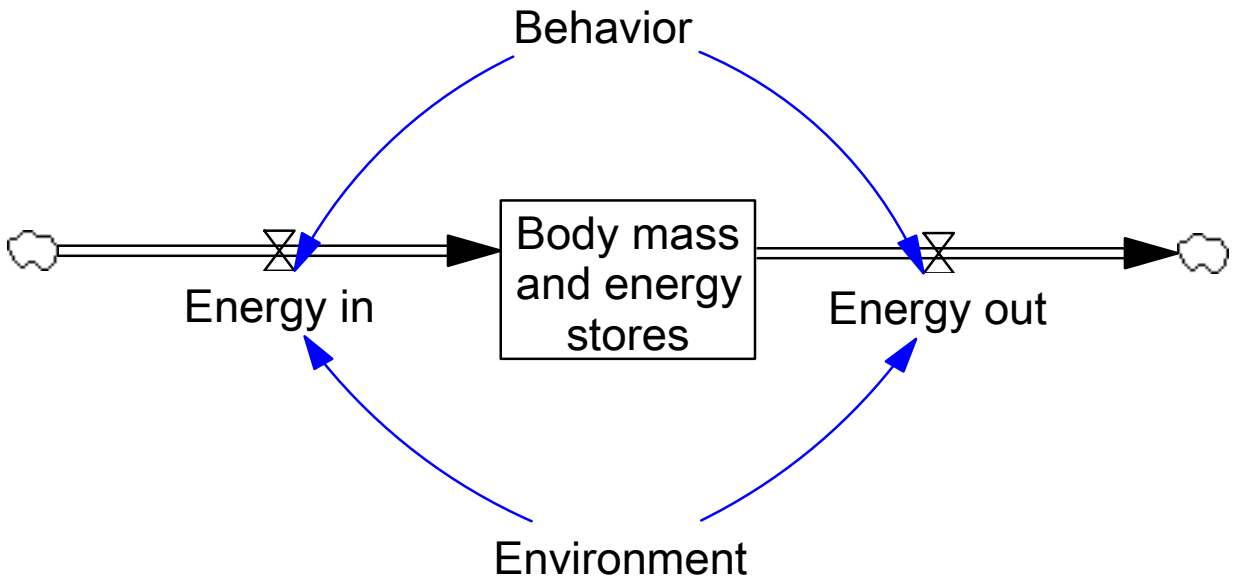
- Obesity is a complex, multi-factorial disease involving genetics, physiology, biochemistry, as well as environmental, psychosocial, and cultural factors
- Participatory approach is needed to implement and sustain wellness school wellness policies, practices, and programs
- *System thinking* can engage school wellness champions in effective *action planning* to achieve obesity-related health recommendations
- *System dynamics models* can facilitate useful post-project *dissemination/scale-up*

A Social Ecological Understanding of Student Health Behaviors



Dynamics of Student Health Behaviors

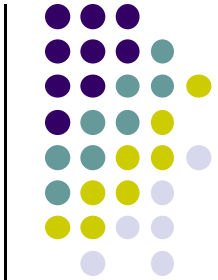
How to unpack (parse) the effects?
What are the main drivers?
What can we change?



Energy stores = Energy in - Energy out

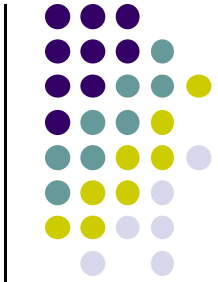
Hamid 2008

Helping SWCs Design Better Action Plans



1. Student Assessment: Engage students in taking a brief electronic health survey to identify biggest health behavior challenges
2. Systems Thinking: With SWC, use the relevant systems models to ‘see’ robust objectives and goals for achieving wellness priorities
3. SMART Action Planning: Select and adapt activities developed to support implementing wellness priorities
4. Evaluating Change: Use system dynamics modeling to synthesize available information about processes and outcomes of implementation efforts

1. Student Assessment: Feedback Reporting on Biggest Health Behavior Challenges



- Generate “Healthy-Me-Meter”
  - Individual report (PDF delivered via e-mail)
  - Aggregate report presented to SWC
- Provides a ‘snap shot’ self-reported key health behaviors and related psychosocial attitudes and barriers about exercise and healthy eating
- When possible, aggregate report show rates of school breakfast and lunch consumption, academic performance, violence/disciplinary actions, and other indicators of social climate in the school

Sample student "Healthy-Me-Meter" feedback report

Thank you for completing the HealthyMeMeter Survey!

The Healthy Me Meter gives you feedback on your current health habits. We created the feedback based on your answers on the Healthy Me Meter Survey. You can use this feedback to help you set SMART goals to improve your health!! Remember that these are general health recommendations. You should talk with your school nurse or doctor about any specific health concerns.

Healthy Behaviors	Your Rating	Feedback Message
Your healthy habits include:		
Eating Breakfast		You eat breakfast on a regular basis and that is great! It can give you the energy that you need to get through a long school day and can prevent you from overeating later in the day.
Sugary Beverage Consumption		Each 12 oz. (one can) sugary drink has more than 10 teaspoons of sugar. Water quenches thirst and keeps you healthy. Keep replacing these sugary drinks with water or homemade tea (iced or hot). Try adding slices of lemon, orange, or lime to tap or seltzer water.
Your health habits that could use improvement include:		
Eating Fruits and Vegetables		Eating fruits and veggies may help you have healthy skin and eyes and keeps your blood pressure in check as well. Try eating more fruits and veggies- consider eating one or more at every meal and for snacks. 
Eating Less Fast Food		You sometimes eat fast food and junk food like cookies, chips or candy. Make healthy choices by eating whole grains, lean proteins, and lots of fruits and veggies to keep your body strong.
Staying Physically Active		Just like we need to eat, we need to move every day. Try to limit time in front of the computer, tv etc. to less than 2 hours per day. Find ways to be more active like walking while you talk on the phone!

Want to improve your health?

Try setting a SMART goal in one of the above areas. Remember to make your goals **Specific, Measurable, Attainable, Reasonable, and Timely.**

Sample "Healthy Me" Student Survey Results
Average Score with Standard Deviation

Goal Assessment	Avg	Std. Dev.	N
Eating Breakfast	46	35.8	126
Sugary Bev and Water	68	15.3	132
Fruits and Vegatables	18	13.0	132
Fast Food	80	16.2	127
Physical Activity	37	26.7	121
Encourage family and friends to exercise with you	29	30.6	115
TV and Video Time	51	25.4	97
Nights per week with at least 8 hours of sleep	37	32.0	123
Eating Self-Efficacy	70	21.4	99
Exercising Self-Efficacy	57	22.3	98
Self-Image Self-Worth	71	33.0	100

Self-reported Barriers to Exercise	Avg	Std. Dev.	N
Belief too overweight	27	34.3	103
Don't like to sweat	32	35.8	105
Lack of skills/knowledge	32	32.8	107
Lack of self-discipline	34	31.1	109
Don't enjoy it	38	33.3	106
Gyms/parks hard to get to	38	33.0	106
Self-conscious	44	37.0	109
Lack of time	52	32.7	110
Need exercise partner	54	36.8	108
Lack of energy	55	31.9	110

Fall 2014
N = 137 students

Surv Date	N	Grade Level	N	Gender	N
08-OCT-2014	19	Grade 9	1	Male	48
09-OCT-2014	65	Grade 10	25	Female	87
10-OCT-2014	28	Grade 11	79	Missing	2
15-OCT-2014	12	Grade 12	30		
16-OCT-2014	13	Other/Missing	2		

Score range: 0-100
0 – 33 Needs a lot of improvement
34 – 66 Needs some improvement
67 to 100 Doing great!

Figure 1 - Diet and Nutrition Goal Assessment

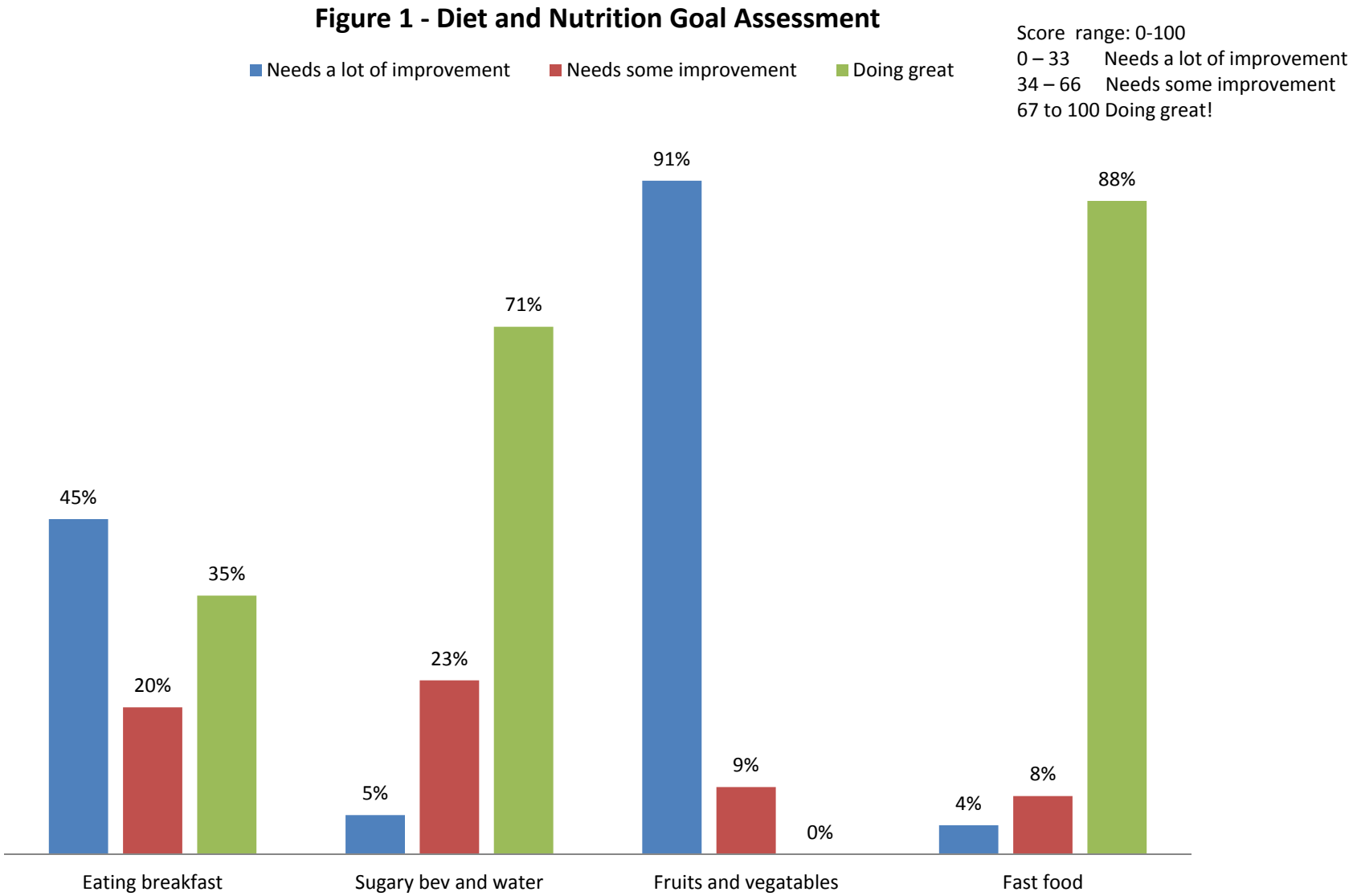


Figure 2 - Physical Activity, Sedentary Behavior and Sleep Goal Assessment

Score range: 0-100
0 – 33 Needs a lot of improvement
34 – 66 Needs some improvement
67 to 100 Doing great!

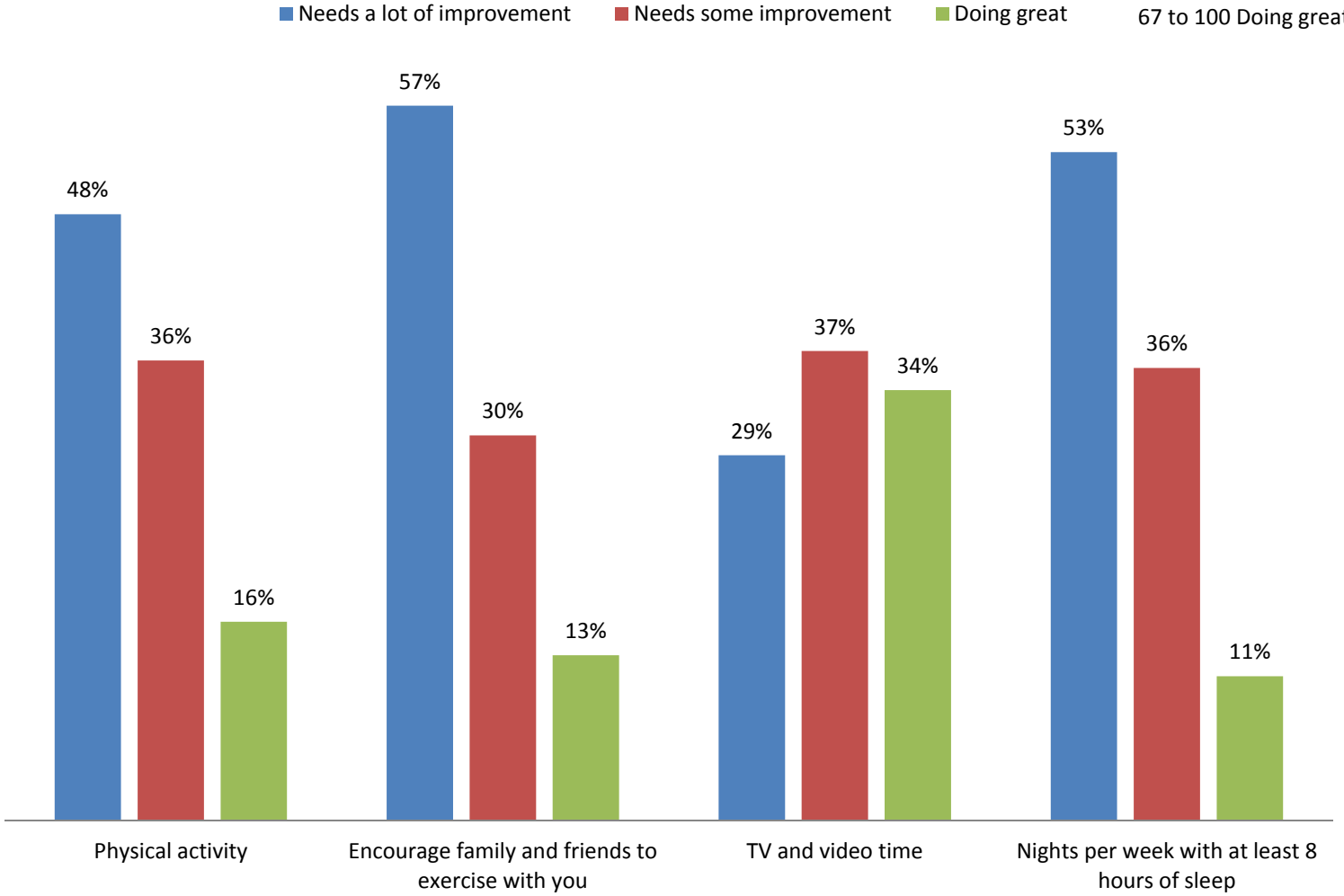


Figure 3 - Psychological Goal Assessment

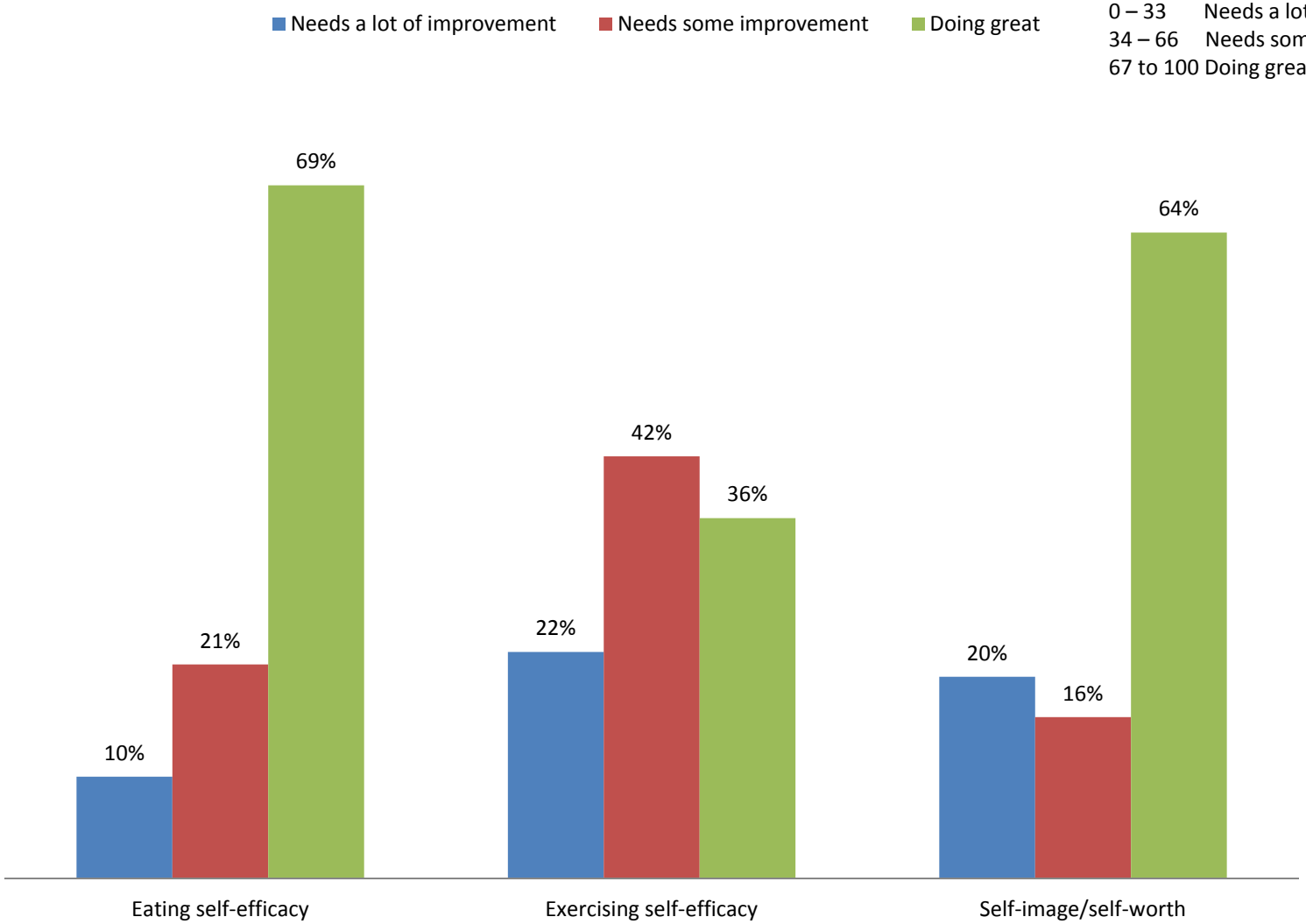
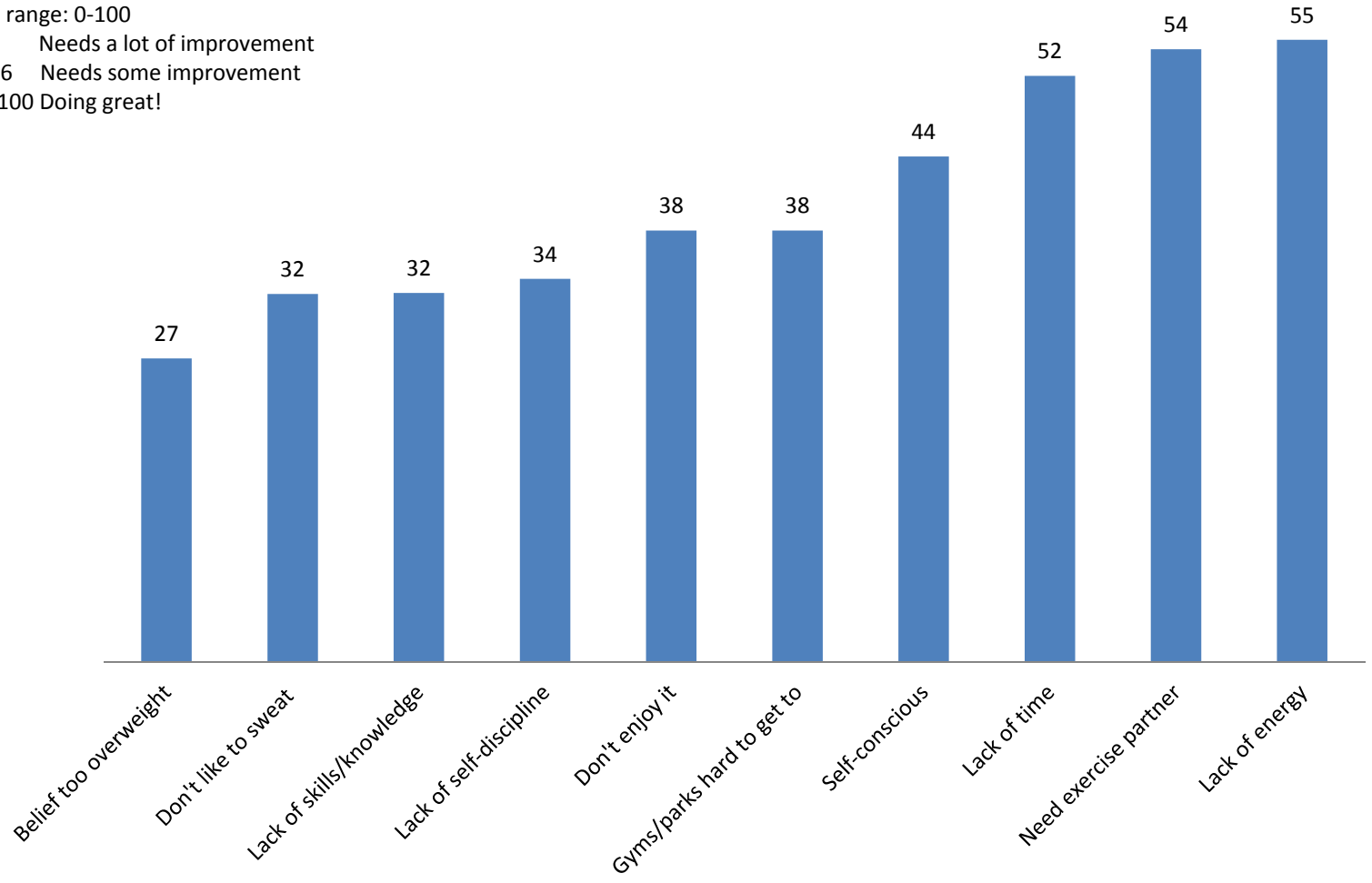
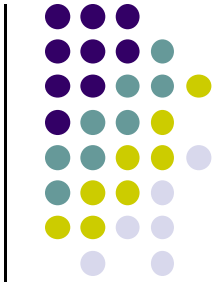


Figure 4 - Self-reported Barriers to Exercise
Average Score (0-100)

Score range: 0-100
0 – 33 Needs a lot of improvement
34 – 66 Needs some improvement
67 to 100 Doing great!



2. Systems Thinking: Use Systems Models to 'See' Robust Objectives and Goals

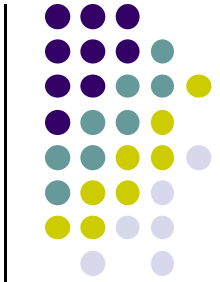


Through early field work, three vitally important systems model themes have emerged:

1. Support healthy choices and behaviors (diet and exercise) via skill-building wellness programs
2. Build collaborative capacity for planning and sustainability of school wellness
3. Grow community support to expand resources for school wellness programming

We have developed a preliminary causal loop diagram (CLD) to illustrate the interdependent, reinforcing dynamics in these themes

Causal Loop Diagramming: A Qualitative Tool for Systems Thinking



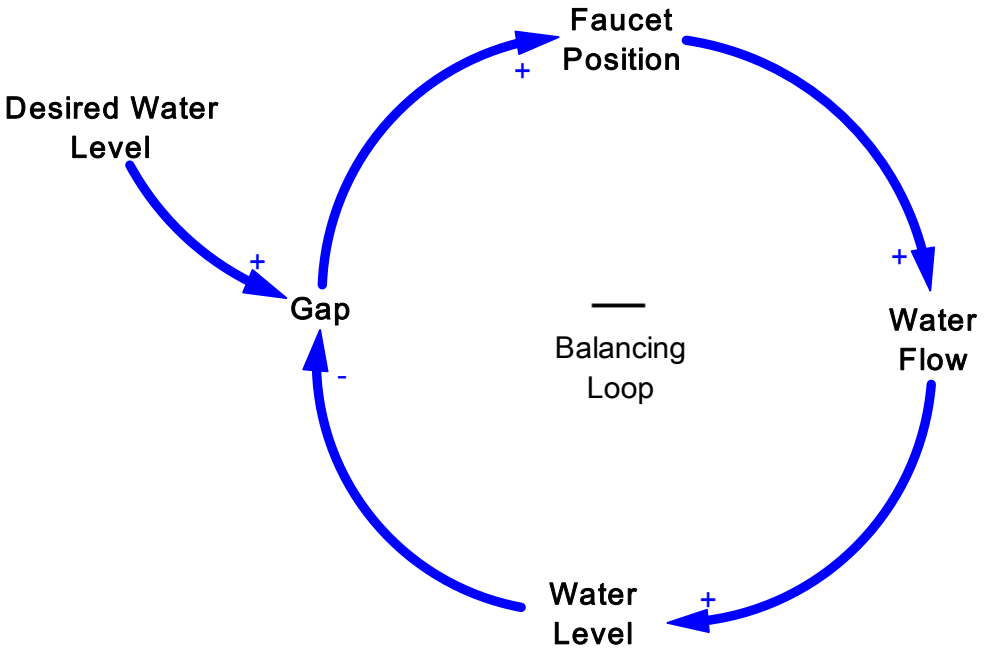
Hallmark

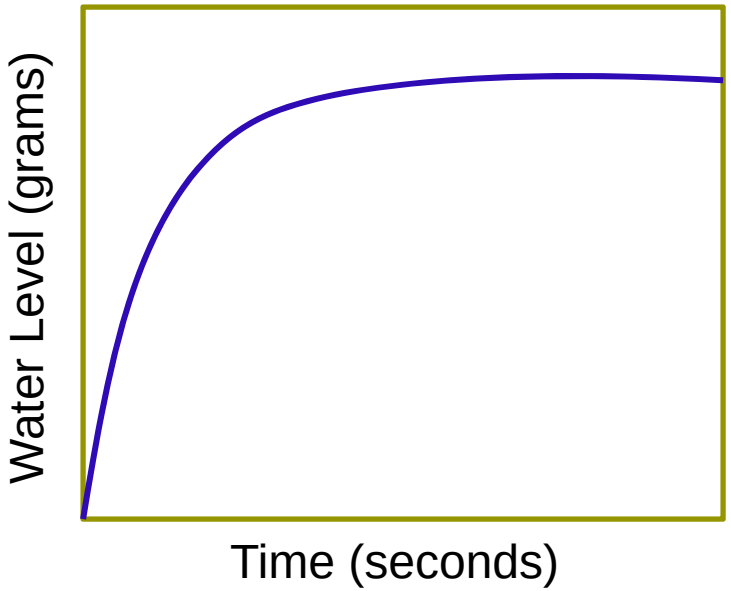
- Identifying feedback structures (‘cybernetics’)
- Understanding how things change (‘causality’)

General assumption

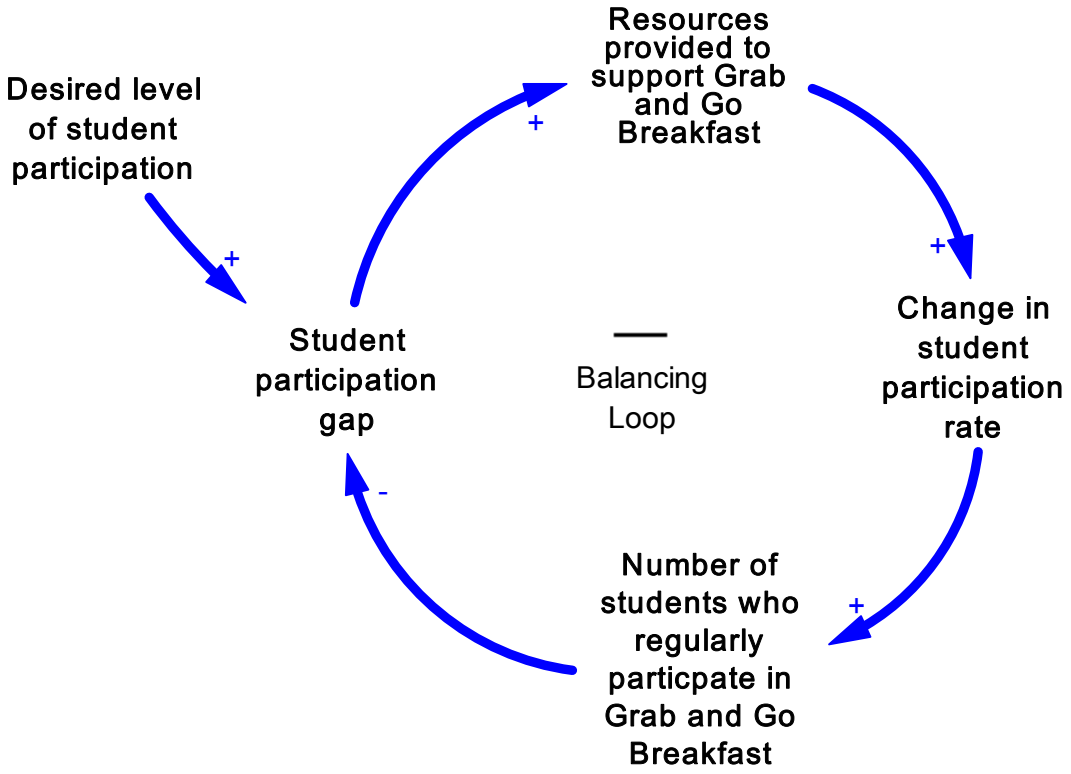
- Problems in natural and human systems have dynamic complexity
- Natural and human systems are ‘goal-seeking’ (i.e., gravitate towards a dynamic equilibrium; a state of homeostasis, sustainability, balance, stability)

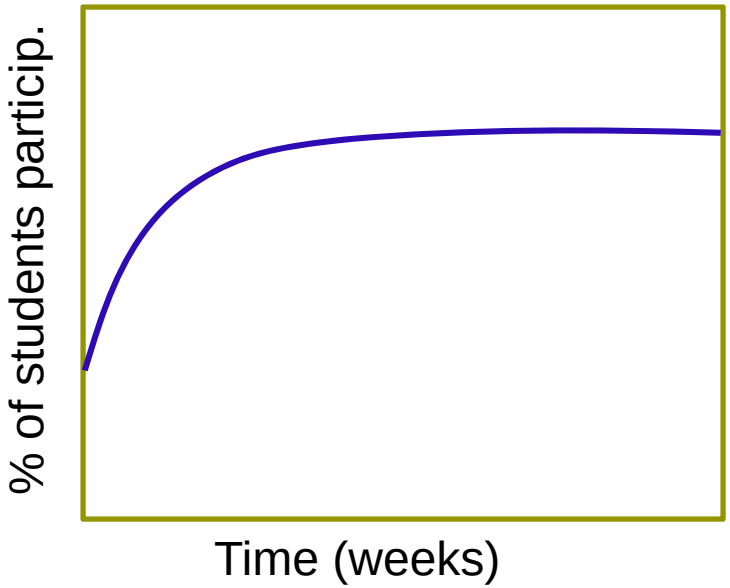
CLD: Filling a Glass of Water



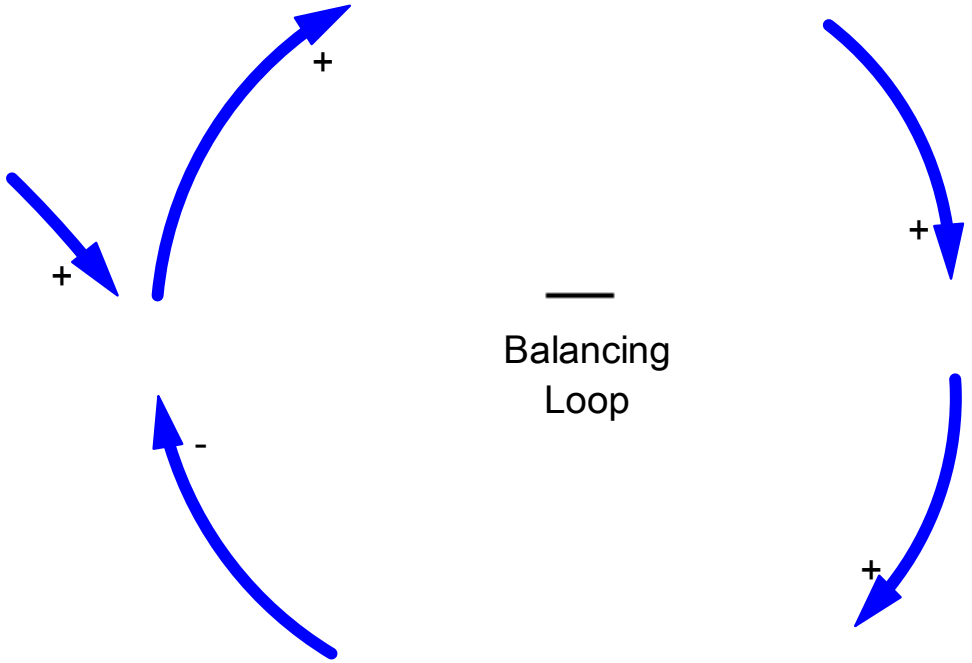


CLD: Achieving 65% Grab and Go Student Participation





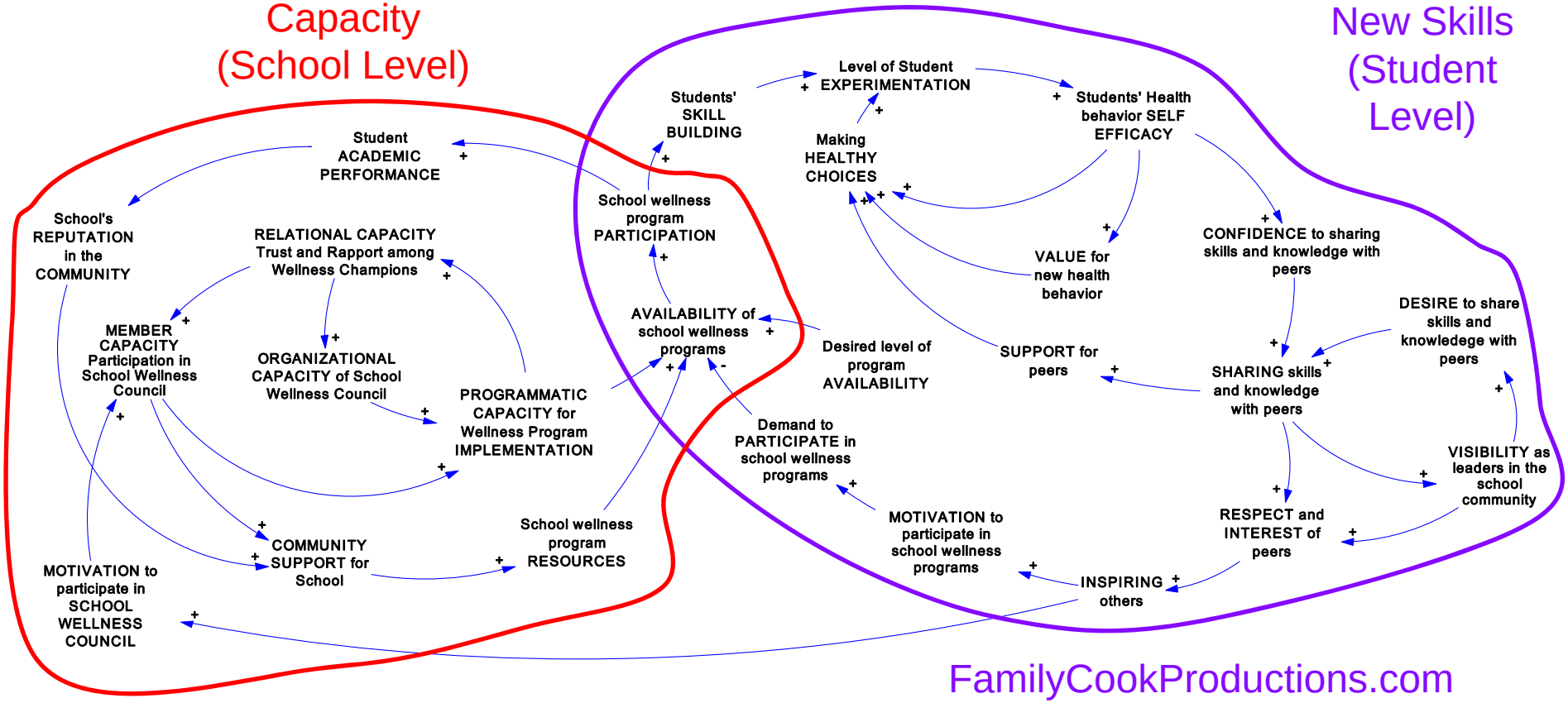
CLD Template: Model a Wellness Initiative of Your Choice



Systems Thinking: CLD of Effective Wellness Program Implementation

Building Collaborative Capacity (School Level)

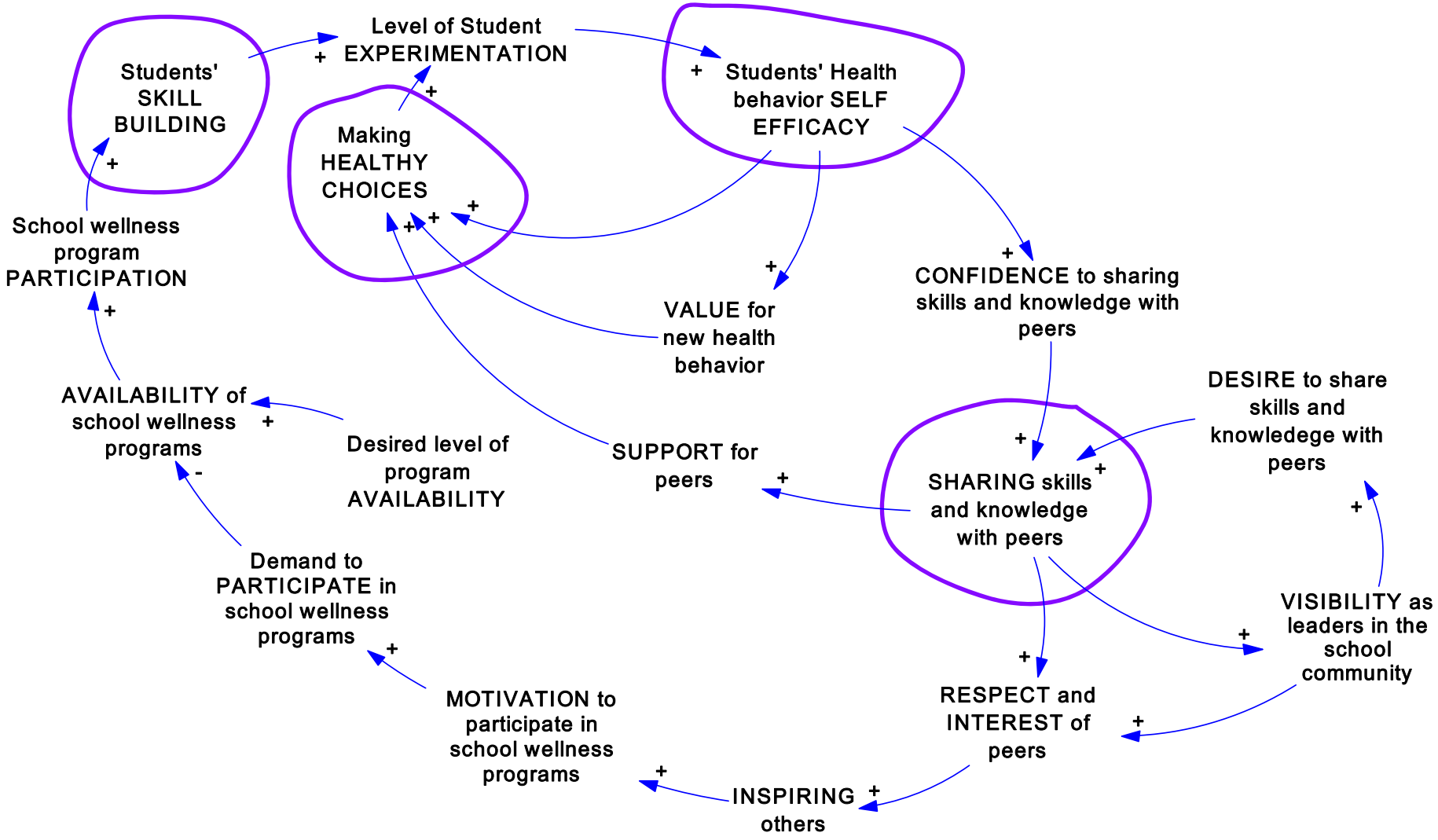
Learning New Skills (Student Level)



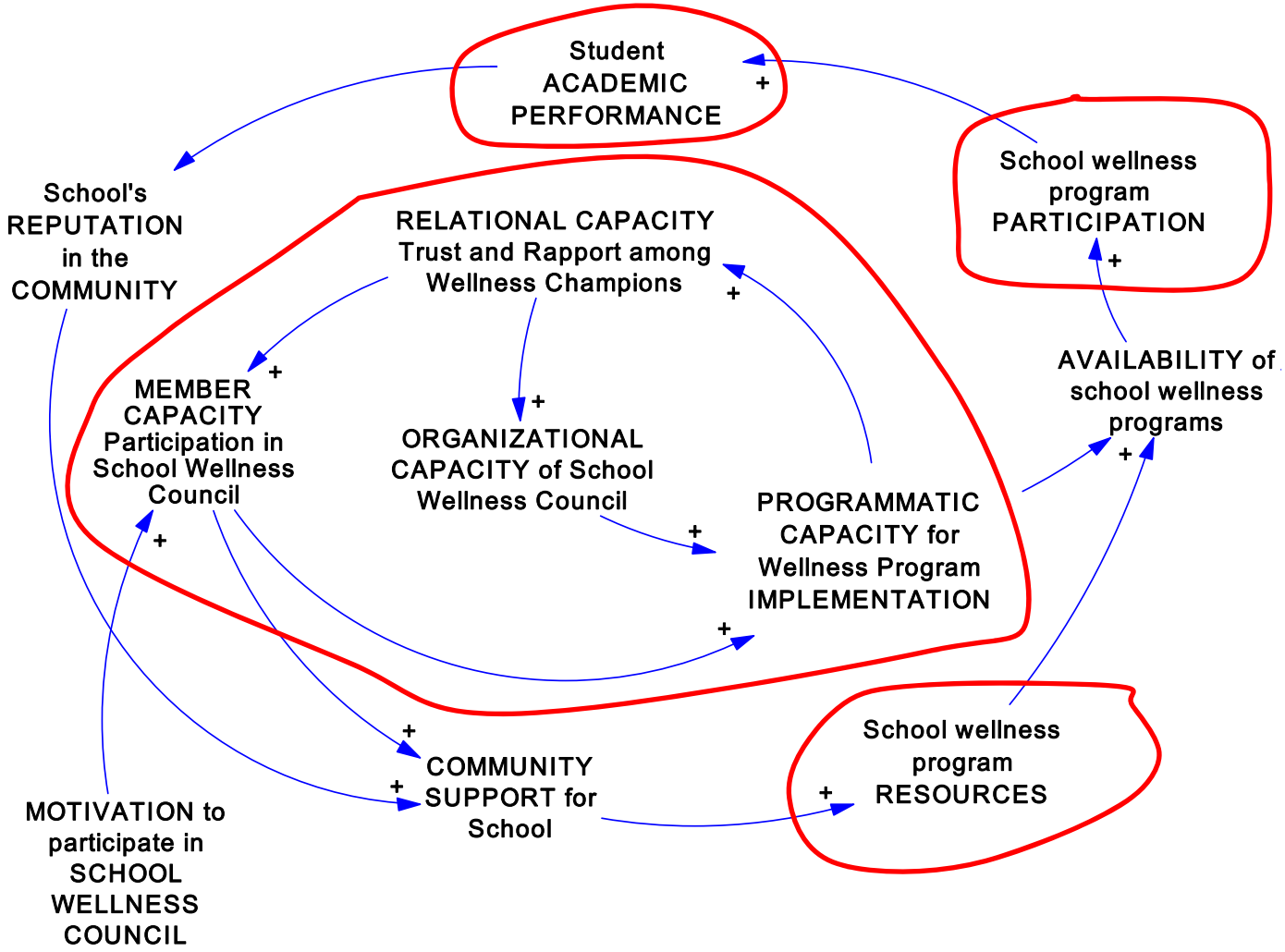
FamilyCookProductions.com

Foster-Fishman et al. (2001)

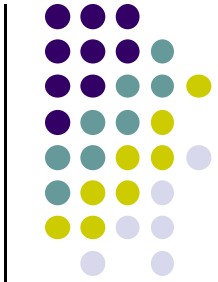
Learning New Skills (Student Level)



Building Collaborative Capacity (School Level)

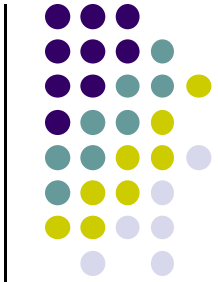


Teen Battle Chef™ Program Goals



1. Learn to cook
2. Absorb nutrition knowledge
3. Be adventurous—try new foods
4. Practice teamwork towards a common goal
5. Develop cultural tolerance
6. Become confident to plan and make meals -
7. Practice public speaking
8. Value eating with others
9. Become a leader and teach others
10. Make healthy food choices

TBC™ Students' Barriers to Making Healthy Choices



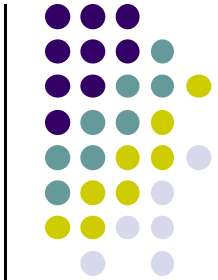
Personal

- Little exposure to many health ingredients
- Little exposure /knowledge that healthful ingredients taste good
- Fears about healthy food tasting bad
- No ability to create healthful meals for themselves
- Perception of not enough money for healthy food/snacks
- Little attn. paid to future health consequences of poor food choices
- Cultural biases against food beyond what is culturally familiar
- No role models who demonstrate a wider diet

External

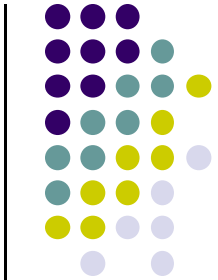
- Little access to healthful foods and varieties of foods
- No kitchen equipment at home to cook
- No kitchen at all to cook
- No family support/encouragement to cook or purchase healthy ingredient
- Family members who say they don't like to eat vegetables/try new foods

3. SMART Action Planning: Select and Adapt Resources from Our Toolkit



- Move-to-Improve/Fitness Share: Activities by student leaders or teachers as ‘do now’ in any class or in the cafeteria.
- Make One Share One/Café-o-Yea: Simple breakfast or snack recipes shared in cafeteria, after school, or at student events. Showcases healthy tasty food and reinforces dietary guidelines.

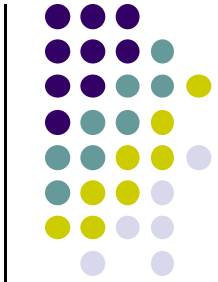
4. Evaluating Change: Use SD Modeling to assess processes and outcomes of implementation efforts



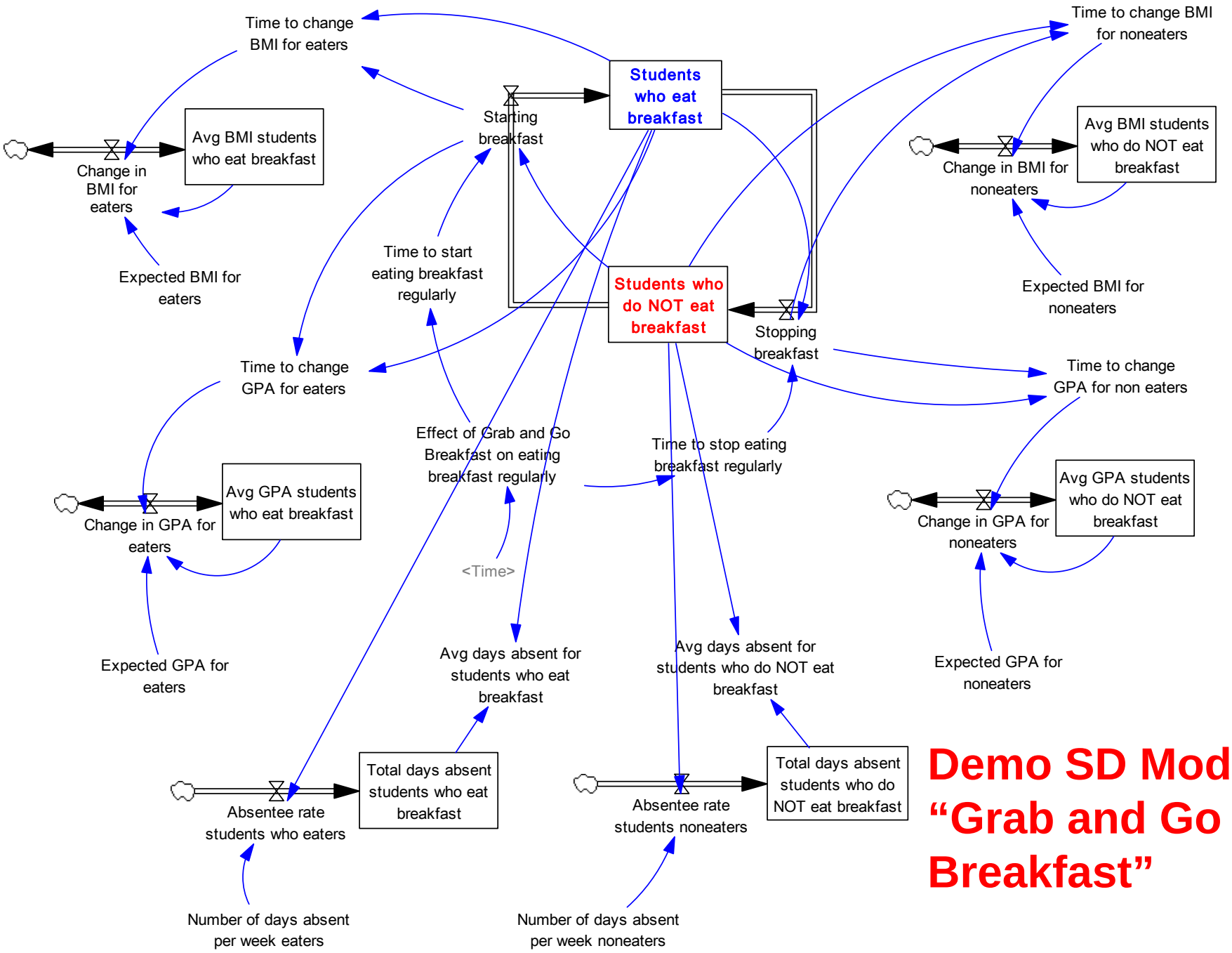
- Apply **RE-AIM**: An acronym for **Reach** (participation rates), **Effectiveness** (outcomes), **Adoption** (acceptability), **Implementation** (intervention fidelity), and **Maintenance** (sustainability of lifestyle changes by students and school programs)
- Deliberate about the following:
  1. Who will/will not being reached? **Reach**
  2. How will these actions/activities make a difference? For whom? **Effectiveness**
  3. What are the biggest barriers/facilitators to implementing these actions/activities? **Adoption** | **Implementation**
  4. What the biggest barriers/facilitators to sustaining these actions/activities? **Maintenance**

Glasgow, 2008

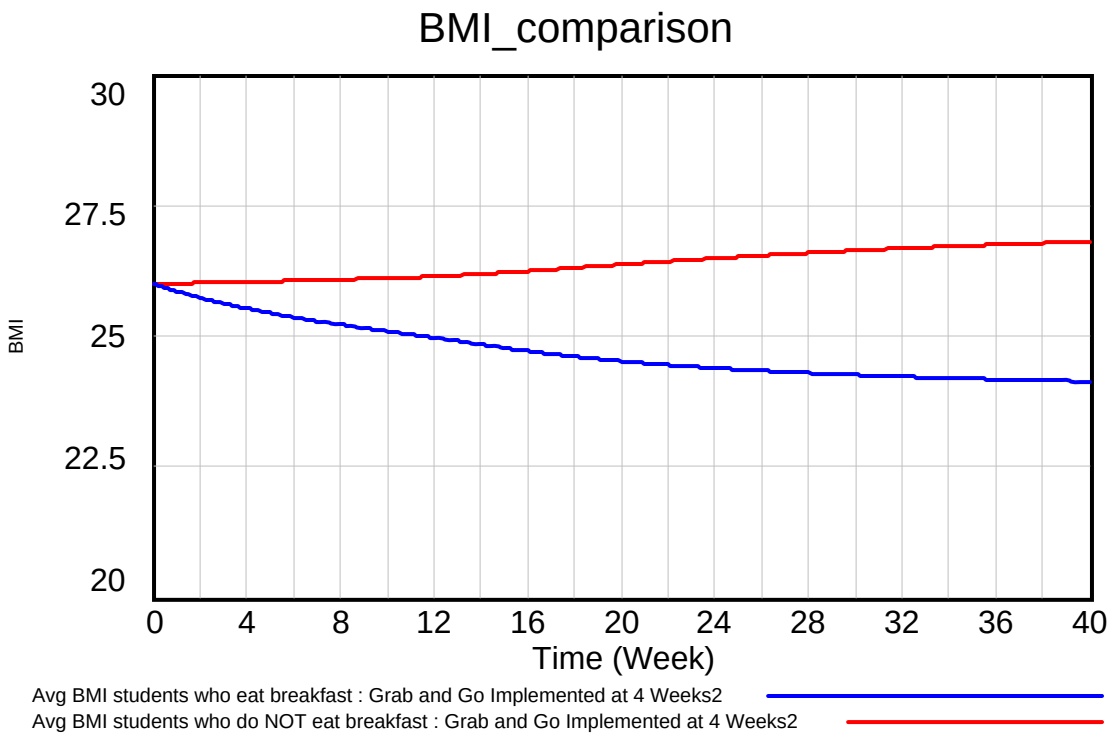
SD Models as Tools for 'Data Synthesization'

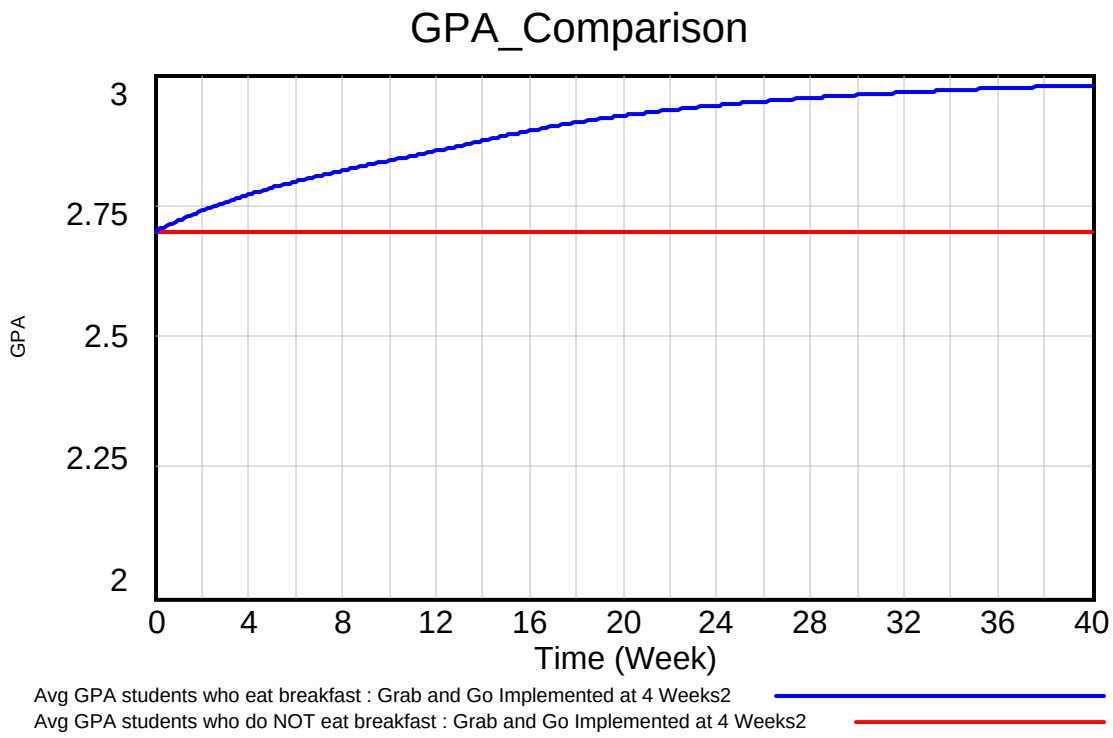


- Cluster randomized design (N=14 schools) will enable multi-level statistical modeling, however:
  - Low statistical power is concern (Type II Error)
  - Quality of data (reliability) is concern
  - Variety of data sources: HC Survey, BMI assessment, qual. org. data, FitnessGram, School Progress Report, School Food Report
- SD modeling builds upon statistical findings and enhances understanding of the intervention

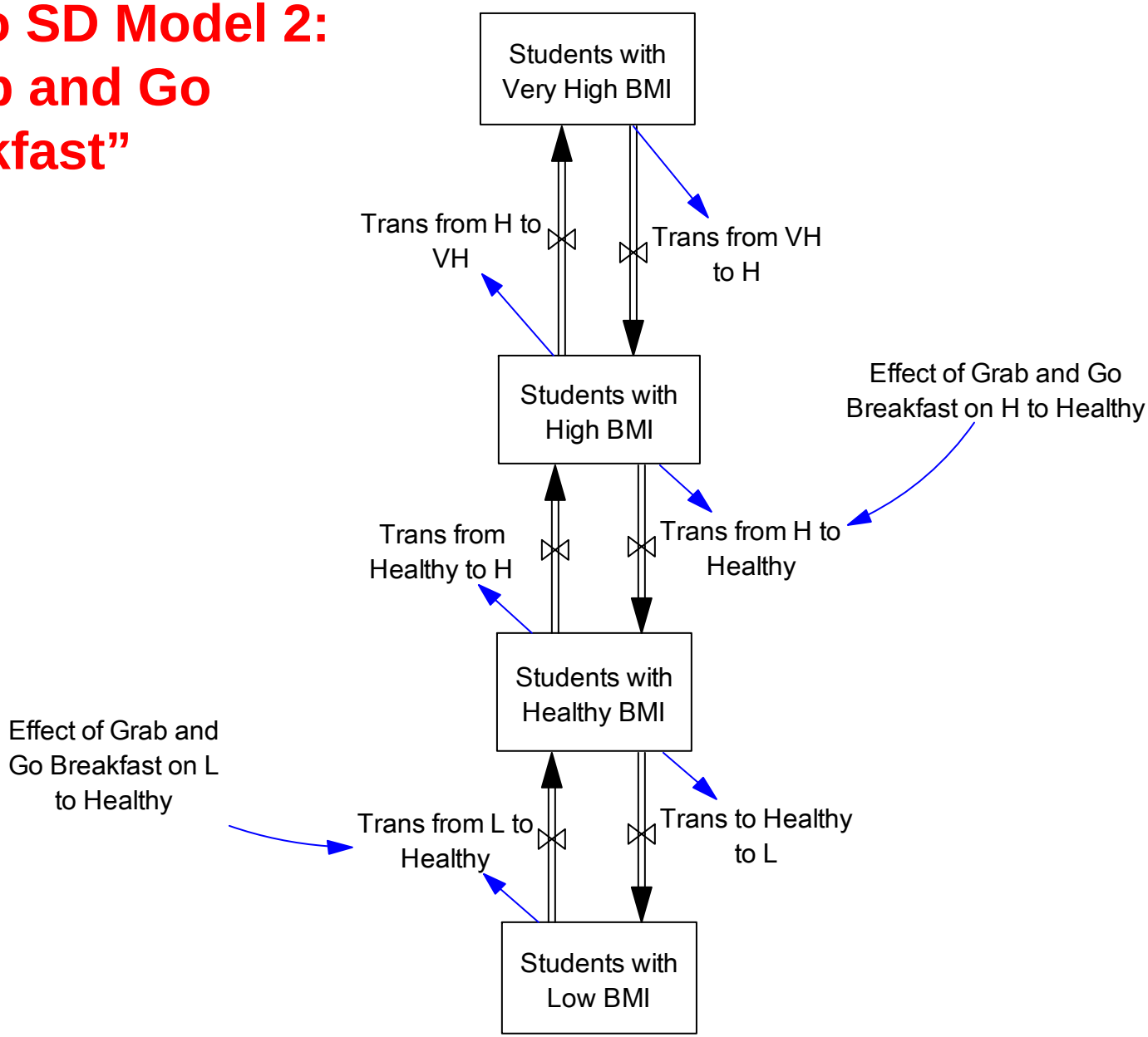


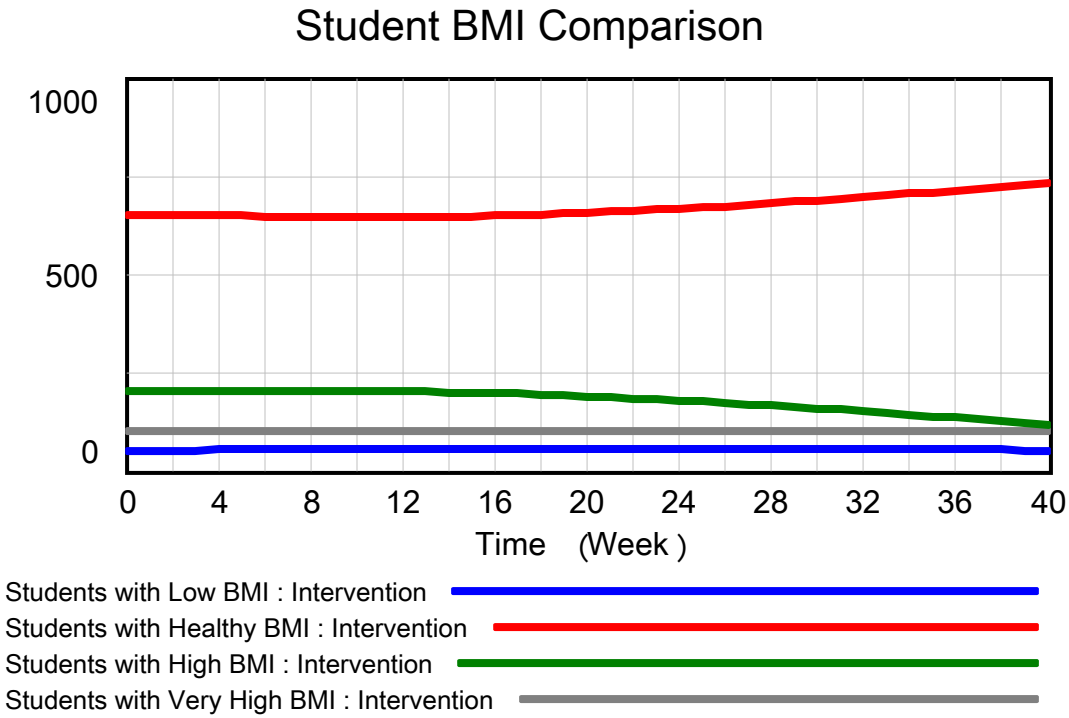
Demo SD Model 1: "Grab and Go Breakfast"


BMI_comparison
30
27.5
25
22.5
20
BMI
0
4
8
12
16
20
24
28
32
36
40
Time (Week)
Avg BMI students who eat breakfast : Grab and Go Implemented at 4 Weeks2
Avg BMI students who do NOT eat breakfast : Grab and Go Implemented at 4 Weeks2

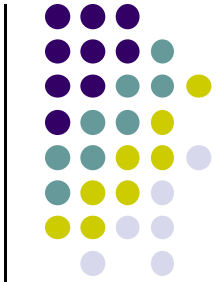

GPA_Comparison
3
2.75
2.5
2.25
2
GPA
0
4
8
12
16
20
24
28
32
36
40
Time (Week)
Avg GPA students who eat breakfast : Grab and Go Implemented at 4 Weeks2
Avg GPA students who do NOT eat breakfast : Grab and Go Implemented at 4 Weeks2

Demo SD Model 2: "Grab and Go Breakfast"



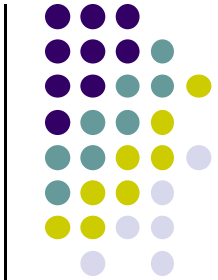

Student BMI Comparison
1000
500
0
0
4
8
12
16
20
24
28
32
36
40
Time (Week)
Students with Low BMI : Intervention
Students with Healthy BMI : Intervention
Students with High BMI : Intervention
Students with Very High BMI : Intervention

Types of Insights from System Dynamics Models



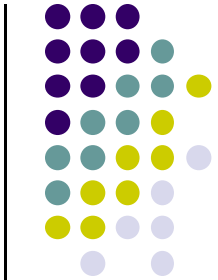
- Understanding of long-term behavior of a system
  - Eventual outcome(s)
  - Impact of parameter values on outcome(s)
  - Robustness of these outcomes to disturbance (i.e., change in parameter values)
- Identification of key causal processes (loop dominance), and high leverage parameters within the system
- Explanation of complex, observed behavior in the real world

SD Modeling is Inherently 'Participatory'



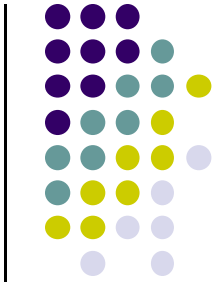
- Uncovering stakeholders' mental models and trusting their expertise
- Cycles of reflection; iterative development
- Essential characteristics of PAR:
  - Supports collaboration investigation
  - Co-learning about issues of concern
  - Sharing of decision-making power
  - Mutual ownership of the processes and the products of project

Concluding Remarks: Co-Learning



- Working with diverse stakeholders who are naïve to systems thinking and system dynamics modeling, I am learning more about how to translate important concepts about the epistemology and methods of robust systems thinking and modeling
- All see the potential of the systems thinking and modeling approach, but I need to make the models more accessible and visually appealing
  - Produce *BrainShark/YouTube* videos to discuss the CLD and the SD modeling with animation
  - In CLD, replace text with graphic, vivid icons
  - Replace templated text with text that describes actual programs (i.e., TBCTM) and local school environs

Concluding Remarks: Value-Added of Systems Thinking and SD Modeling

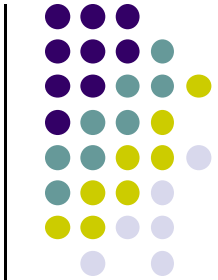


- CLD helps communicate key objectives for both students and for the school:

1. It explicitly raises consciousness about the utility of implementing wellness programs that build students' self-efficacy **and** skills to make key health behavior changes
2. It shows how implementing such programs is determined, in part, by level of available resources
3. It makes the proposition that collaborative capacity (cc) generates resources for wellness programming, and that, in turn, cc develops through implementation of strong programs that build skills and self-efficacy

- Validated simulation models are powerful tools for 'data synthesization' **and** for post-study dissemination efforts

Conclusions



- Ultimate aim of the project is to add value to existing process models, to learn how to better support schools in creating products that support design, implementation, and evaluation of school wellness initiatives
- Approach:
  - Develop working relationships with the participating schools and with our key partners
  - First 1.5 years: Participant observer
  - Now, gently expose schools and key partners to the concept of systems thinking and system dynamics modeling

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THANK YOU!