“Change the Changeable” Framework for Implementation Research in Health

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Abstract: In recent years, a “participatory” system of community members and researchers has become a key factor to obtaining the best outcomes to create a better world. The authors previously suggested the problem structure change theory to find how to address social issues. In this paper, we suggest the “change the changeable framework” with three approaches for community-based program implementation: 1) Share the value of the change the changeable, 2) Systematize the process of a problem structure change, and 3) Build a sustainable system and discuss a case study based on the framework. In the case study, we conducted a safety education curriculum for injury prevention that consisted of what is injury prevention, playground safety, indoor safety, and photovoice project. We introduce an injury surveillance system and a risk recognition system as new tools for the collaboration of human intelligence and artificial intelligence.

1 INTRODUCTION

In recent years, a “participatory” system of community members and researchers has become a key factor to obtaining the best outcomes to create a better world. For example, in the field of service design, designers have taken a co-design or co-creation approach to develop new products based on people’s needs. Co-design is defined as the creativity of designers and non-designers working together from the beginning of the development process (Sanders, 2008). In the field of engineering, a living lab is a new research approach for making innovations happen. In living labs, users are involved in developing, creating, prototyping, validating, and testing new products, services, or technologies in a real-life setting (Schuurman, 2011, 2016). In the public health field, the community-based participatory research (CBPR) approach has been widely used to eliminate health disparities. In CBPR, community members affected by a health issue are actively involved as a partner in all phases of research (Minkler, 2004; Wallerstein, 2010).

Co-design, living labs, and CBPR might seem unrelated, but they use the same approach to reach their goals. To the authors, it seems that a boundary between professionals and nonprofessionals has become unclear in many fields. The key is that all powers, which include knowledge, skills, and life experiences that people have regardless of their expertise, should be recognized and wisely used to make innovations happen or to find how to address social issues. In this study, we defined a participatory system as a group of assets that functions together to achieve particular goals. The examples of these assets are not only people who are multidisciplinary professionals and nonprofessionals, including parents and children, but also community resources such as hospitals, schools, and daycare centers.

The authors previously suggested the problem structure change theory to find how to address social issues, as shown in Figure 1 (Nishida, 2017). This theory has three variables: variable A, which is what we want to change, variable B, which is what we can change, and variable C, which is what we cannot change or is difficult to change. Social problems often seem rigid and unchangeable because they are discussed based on the relation between variable A and variable C. By adding operational variable B (changeable things) to a problem structure, the structure is transformed to one that can be changed.

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In this paper, we apply this structure to a particular social issue, which is improving people's health by preventing injuries.

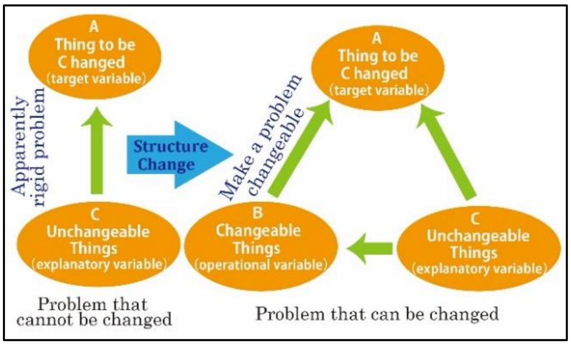

Figure 1: Problem structure change theory.

From the perspective of the problem structure change theory, co-design, living lab, and CBPR fields face unique limitations for addressing social issues. In the field of co-design and living labs, B variables are often already fixed in the first place because most professional people are knowledgeable about the latest technologies. Their primary interest is to implement such technologies, but they often lack an impact evaluation of how a society changes after the technology is implemented in a community. On the other hand, in the field of CBPR, public health professionals always start with health issues, which are the A variables (things to be changed), and they try to translate what science says about appropriate behaviours through education. In comparison with engineers, health professionals are generally not eager to apply new technologies, such as artificial intelligence (AI) and the Internet of Things (IoT), and they tend to practice health education in the traditional way. It seems that researchers in co-design, living lab, and CBPR fields have suffered from the A-C structure on the left side of Figure 1 to obtain ultimate outcomes.

To change the A-C structure, it is necessary 1) to identify all the possible B variables and to understand a precise problem structure by collaborating with people across many different fields, and more importantly, 2) to gain the power of B identification by community members so that they can sustain a healthy community by themselves.

Recently, information communication technology (ICT) in education has rapidly become popular and advanced. Rodriguez et al. used ICT as a tool for elementary school education and implemented a system to create a school network at the national level in Panama (Rodriguez, 2009). Terton and White developed a computer-based educational game for children to promote physical and social engagement and discussed the benefits of computer-based educational gaming (Terton, 2014). In addition, advanced technologies including IoT and AI are currently available for community-based programs. Those technologies can be used for changing A-C structure and empowering community members.

In this paper, we first propose the "change the changeable" framework by expanding the concept of "participatory". We present a children's health education project based on the framework. Then, we discuss how a health problem structure can be changed from the viewpoint of a sustainable school system. Finally, we introduce a risk recognition system that we developed as a future health education tool.

2 "CHANGE THE CHANGEABLE" FRAMEWORK

The three-step approach presented in this section describes how to establish a strong community health program in one's community. The conceptual framework of change the changeable is shown in Figure 2.

The three steps are as follows:

1. Share the value of the change the changeable framework with community members.
2. Systematize the process of a problem structure change.
3. Build a sustainable system.

2.1 Step 1: Share the Value of Change the Changeable with Community Members

To change the A-C structure, it is necessary to identify variable A as a target and possible B variables through co-designing with community members and other collaborators from various fields. In public health, the following are critical for program implementation: engaging all stakeholders, developing a trusting relationship, and more importantly, realizing that all stakeholders have their own B's.

In this step, the content-driven approach is key. Most researchers are very likely to start with data collection because the data indicate the direction of their research. However, it is not easy for community members to experience the value of data, and data collection is usually a huge burden for a community.

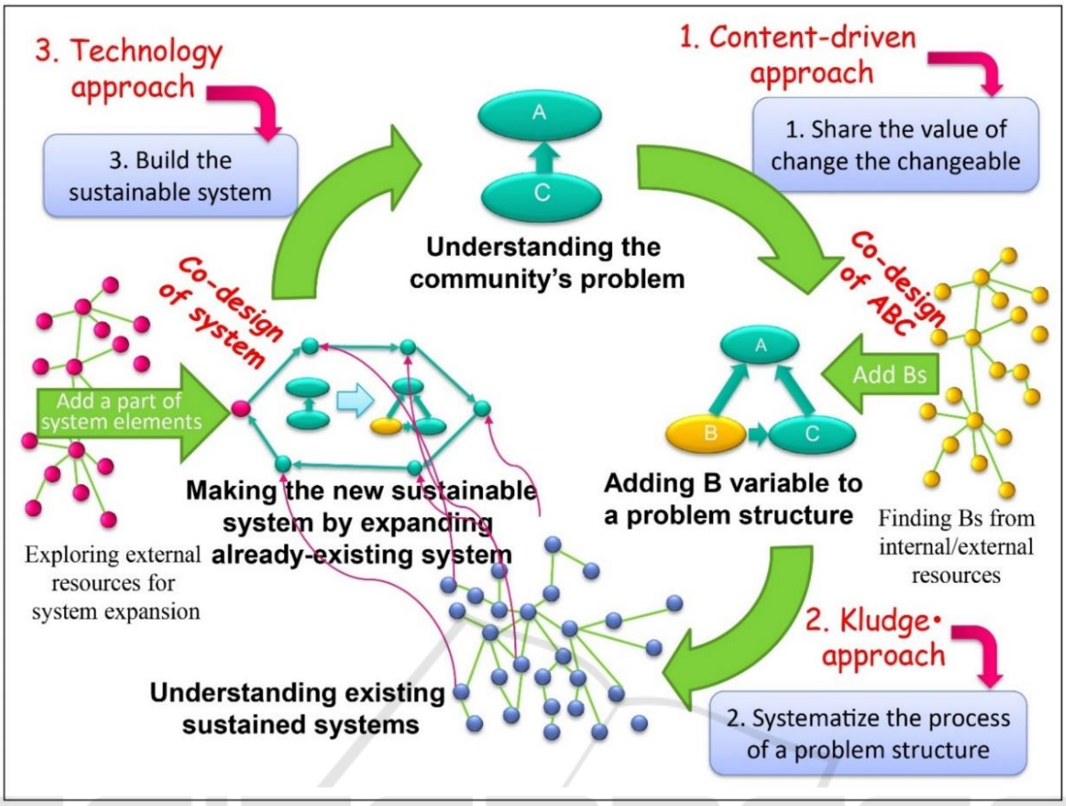

Figure 2: The change the changeable framework using the 1) content-driver approach, 2) kludge approach, and 3) technology-use approaches.

Therefore, a relatively easy and useful activity, such as a one-hour workshop or a health education class, should first be presented so that community members can learn visible positive outcomes in return for accepting a small change. Then, they realize research participation is valuable.

2.2 Step 2: Systematize the Process of Problem Structure Change

When community members see positive changes for a particular issue and are ready to make other changes, it is important to keep and sustain their ability to change. For example, if community members decide to implement a health education program at school, many questions arise: e.g., who provides the classes, when the program is offered, and who is in charge. Therefore, step 2 is finding a way to systematize the process of making changes while developing a trusting relationship.

Creating a new system from no system or from an existing system as an independent system is usually difficult for a community. To overcome such a barrier, the authors suggest the kludge approach. According to the dictionary (Dictionary.com, 2017), kludge is defined as "a software or hardware configuration that, while inelegant, inefficient, clumsy, or patched together, succeeds in solving a specific problem or performing a particular task". This tells us that it is important to realize that addressing an issue is a priority even if the performance is awkward. Researchers need to find a system that is already working in a community and expand that system. Expanding a system could be easier than embedding a new system in a community.

2.3 Step 3: Build a Sustainable System

When researchers successfully systematize the new system by expanding the originally existing system, it is still necessary to strengthen it. To do so, technologies play a huge role because they can reduce the task load and maximize the efficiency for work (the technology-use approach). In reality, however, many people tend to stay away from new technologies rather than accept them. If people understood that technologies can accelerate their efforts to reach their goal, then they would be more likely to accept them.

3 CASE STUDY

In this section, we discuss a case study of injury prevention education for children and its outcomes, and then reflect it based on the three steps of the framework.

3.1 Project Overview: Injury Prevention Education Curriculum

A comprehensive safety education curriculum was developed, implemented, and evaluated for 5th graders of Fujimidai Elementary School in Tokyo. This school was certified as the International Safe School (ISS) in 2016. ISS is a school that carries out activities to promote school safety and is awarded by the World Health Organization Collaborating Centre on Community safety Promotion at the Karolinska Institutet, Stockholm, Sweden (International Safe Schools Certifying Centers, 2017). The school's teachers, students, and community members collaborate each other to improve school environment by identifying B variables and changing the changeable. The safety education curriculum we developed consisted of injury prevention explanations, playground safety, indoor safety, a photovoice project, and preventive action. Photovoice is a qualitative community-based participatory research method using photographs to reflect a community's strengths and concerns (Wang, 1997). From the perspective of problem structure change theory, B variables can be classified into three categories, known as the 3E's: Enforcement, Environmental modification, and Education. To make these traditional three E's of injury prevention more suitable for school children, we modified them to the children's three C's: Creating rules, Changing the environment, and Communicating to friends and family. In the photovoice project, students were asked to take pictures that showed risks as well as factors promoting school safety. Then, they wrote how to reduce the risk and to increase safety based on the 3C's.

3.2 Health Education Outcomes

Thirty-eight students took the curriculum. Students presented 27 pictures from the viewpoints of the 3C's. As one example of promoting factors, a student took a picture of a counseling room and said, "The state of our mind affects injury risk. I feel safe when I consult a school counselor." For a risk factor, students mentioned the risk of a fall by going up the stairs by skipping every other step and the risk of a crossing collision in front of a restroom when students run. Examples of photovoice pictures are shown in Figure 3.

Students also developed a photo R-map (Figure 4). An R-map is a 4×4 matrix that shows risk levels divided into two levels of frequency of occurrence on the vertical axis and two levels of injury severity on the horizontal axis. The R-map is widely used in engineering fields for risk assessment. Students placed their pictures based on their opinions about injury frequency and severity. Sometimes they relocated the pictures based on class discussion.

Figure 3: Examples of photovoice.

Figure 4: Photo R-map.

During the preventive action time, students divided into three groups, one for each of the three C's, and discussed what they could do to improve school safety. The first C group created new rules. The second C group cleaned their classroom in places where students might trip over an obstacle. Moreover, for a place that was difficult for the students themselves to modify, they wrote a request letter that stated where to modify and the reasons behind the requests. This letter was given to the school principal. The third C group created educational posters, and some of them wrote a manuscript for a school broadcast to promote safety behaviours schoolwide.

To evaluate the effectiveness of the project, we conducted a survey asking students if they gained new knowledge of injury prevention and if the curriculum raised their willingness to learn more about injury prevention. The willingness was asked on a scale of one (low) to ten (high). The Wilcoxon signed-rank test was used to determine its effectiveness.

The evaluation survey results showed that 91% of the students said that they gained new knowledge of injury prevention. As examples of new knowledge, students stated, "One's state of mind and environmental factors cause injury, much more than what I expected" and "To prevent injuries, it's critical to consider one's behaviours and environmental conditions around us." In addition, we found that the willingness to learn was significantly increased from 6.24 on average to 7.56 (p = .001) (Figure 5).

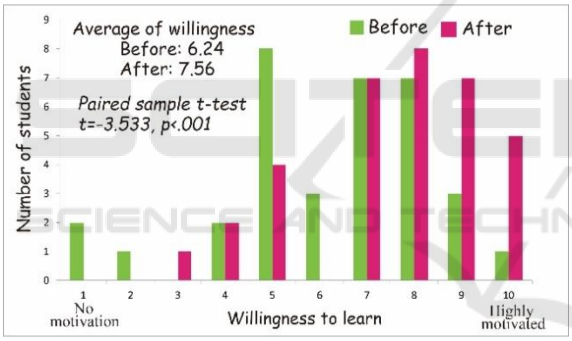

Figure 5: Changes in students' willingness to learn.

As a result of sending a request letter to the principle, a tile floor at the entrance that caused slips during rainy days was changed to non-slip floor tiles.

3.3 Change the Changeable Perspectives of the Project

3.3.1 Sharing the Value of Change the Changeable by using the Content-Driven Approach

When this project had just started, we recommended the school to start injury data collection to identify the school's injury risk. However, as discussed in subsection 2.1, it just did not work out. Then we learned that school teachers were very interested in science-based tools for injury prevention education because their expertise is not an injury prevention, and it is hard for them to gather evidenced-based injury prevention messages for students. Thus, we developed educational materials by using our expertise gave the materials to the teachers. A snapshot of the materials is shown in Figure 6. By collaborating with teachers to implement an effective injury prevention class, we successfully built a trusting relationship with the school teachers.

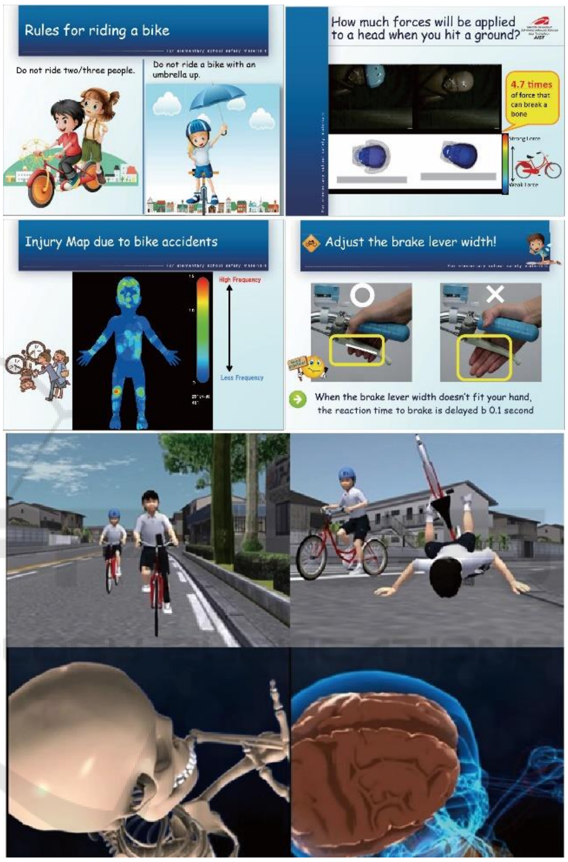

Figure 6: Snapshot of the class materials.

3.3.2 Systematization of a Problem Structure Change by using the Kludge Approach

When we discussed how to start a health education curriculum, we found out that a unit for injury prevention was required as a part of the health and physical education (PE) curriculum for 5th graders. Thus, we integrated the curriculum into the existing PE class and taught it over a five-week period. The PE teacher was in charge of playground safety, indoor safety, and a part of the photovoice project, and we took responsibility for an explanation of injury prevention, the photovoice presentation, and the prevention action time. By integrating our education system into the existing school curriculum system, our developed injury prevention course has become a required unit for 5th graders at Fujimidai Elementary School.

3.3.3 Building the Sustainable System using the Technology-Use Approach

One of the huge successes during collaborations for the injury prevention class was that school teachers started to understand the meaning of data and to want to collect injury data at school. As a means of developing effective and convincing class material for students, the values of the data outweighed the time and effort of data collection. This is where technologies came in. We developed an injury surveillance system for schools. The system is capable of collecting, aggregating, analysing, and searching data of injuries. The system also has a function called “Body-graphic Information System” (“BIS”) that enables us to express, collect, retrieve, and analyse external injury geometric data (Figure 7).

Figure 7: Injury surveillance software.

The injury education project has been conducted since 2013, and Fujimidai Elementary School decided to use the surveillance system at the end of their school fiscal year. Between April 2014 and March 2017, 704 instances of injury were collected from the school. As of April 3rd, 2017, the total number of students enrolled in Fujimidai Elementary School was 302 children. As shown in Figure 8, the number one cause of injury was falls (245 cases) followed by collisions (202 cases), cuts (60 cases), and pinching (34 cases).

Figure 9 shows the body parts that were injured due to falls. A red area indicates a high frequency of injury. The analysed data were integrated into the health education class and helped students recognize their own school’s problems.

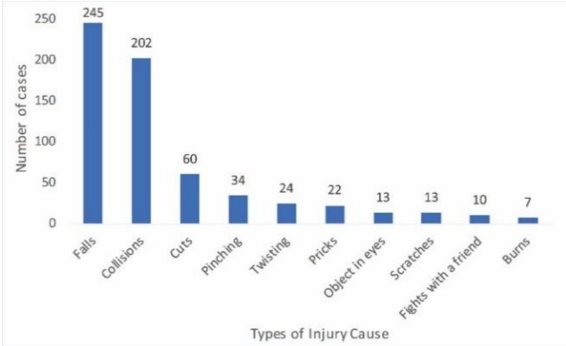

Figure 8: Types of injury.

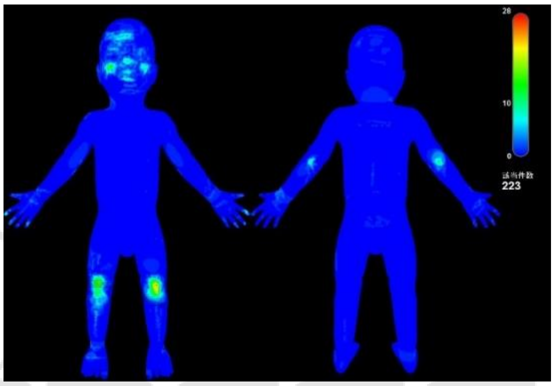

Figure 9: Fall injury analysis using BIS.

Moreover, we developed an injury recognition system by using pictures of the photovoice project. The system is based on the convolutional neural network (CNN)-based model “RotationNet” (Kanezaki, 2016; Savva, 2017). The system takes multi-view images of an object as input and estimates both the object’s pose and category. The method treats the pose labels as latent variables, which are optimized to self-align in an unsupervised manner during training with an unaligned dataset.

Figure 10 shows the result of stair recognition. The system automatically extracts view features (top photo), and then chooses a specific viewpoint based on the scores of the predicted category. Once the system recognizes an object, it indicates possible injuries that commonly occur in and around the recognized object (bottom photo). Students used this recognition system to discuss what preventive actions can be taken to avoid injuries.

Figure 10: Output of the risk recognition system.

4 DISCUSSION

Change the changeable framework suggested a way of bridging the gap between community members and researchers. Using three steps with three approaches is critical to establishing a sustainable system. A sustainable system combines the power that community members have and the knowledge and skills from external resources, and does not proceed with the project based only on the researchers’ intentions. As in the definition of kludge, even though researchers think that the way of proceeding on the project may seem inefficient, ineffective, or clumsy, whatever action acceptable to community members is most important because this is how community members keep participating in a project.

Moreover, carrying out the project according to the community members’ desires helps them to enjoy changing the changeable, and this is an invaluable outcome for community-based programs. As emphasized in subsection 2.1, starting with data collection to develop a community-based participatory system usually does not work. Researchers need to convince community members that starting a project is actually valuable to them even though they need to undertake some tasks. So far, the authors have successfully implemented community-based health education programs at five schools, including a middle school, by using the change the changeable framework. In addition, community-wide injury surveillances were started in two cities.

Our developed injury surveillance system and risk recognition system helps people learn the injury risks around them. Injury data collected from the surveillance system (BIS) are integrated into class material development to promote student learning after the system was installed. Understanding injuries occurred in their school using BIS and predicting plausible injuries using the AI-based recognition system brings home the fact that injuries can actually occur to them. Injury data localization based on the technologies is powerful to heighten the perception of injury susceptibility. We developed these systems to promote interactions between human intelligence and artificial intelligence. Utilization of these systems is one example of future injury education tools that will connect people and people, communities and communities, people and knowledge, and problems and solutions.

5 CONCLUSIONS

We suggested the change the changeable framework and discussed a health education program based on the framework. Our previous experience of implementing a community-based health program showed three useful approaches for program implementation: 1) content-driven approach, 2) kludge approach, and 3) technology-use approach.

We conducted a case study of an injury prevention education project that consisted of classroom lectures and a photovoice project. During the photovoice presentation class, students presented 27 pictures from the viewpoints of the children’s 3C’s (Creating rules, Changing the environment, and Communicating to friends and family). They also created photo R-maps using their photovoice pictures. The project’s evaluation survey indicated that the students’ willingness to learn about injury prevention was significantly increased.

We hope that the change the changeable framework will be applied to various community-based programs and expand our knowledge of implementation science.

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