Investigating Japanese Ijime (Bullying) Behavior Using Agent-Based and System Dynamics Models

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Abstract. In the recent years, observing *Ijime* (i.e. Japanese bully) among Japanese students has been a growing concern. To understand the effect of this behavior in a detail level, we build an Agent-Based Model (ABM) and conduct a set of experiments. In the model, interactions occur between victim and bully as Prisoner Dilemma game. A System Dynamics model is also built and simulated to verify robustness and examine effects of the assumptions in ABM model. The results indicate that students can attend higher social standing by being not cooperative. As such, if one is victim, it is recommended not to comply with the bully. In the case of being bully, one needs to take the role seriously. Thus, by encouraging victim to be aggressive toward bully, the effect of *Ijime* can be alleviated.

Keywords: Iterated prisoner's dilemma · Ijime · Bully · Agent-based modeling · System Dynamics

1 Introduction

In the recent years, *Ijime* or bullying has been one of the concerns among Japanese students at school. It is one of the major factors that leads to suicide in many cases [7] especially in younger ages. The root of *Ijime* comes from the Japanese emphasize on conformity as it focuses on harmony of group over individuality. According to [8], mental aggression toward victim is a main method of action such as peer ignorance. Furthermore, the effect of *Ijime* is also amplified by its structure. Comparing to traditional bully, *Ijime* structure consists of four actors: (I) bully, (II) victim, (III) supporter and (IV) bystander. Bystander, special to *Ijime,* refers to a student who avoids being involved with *Ijime*. Such avoidance can be represented as to change his/her relationship with the victim or being neutral in regard to bully. The bystander's role become important in *Ijime* because he/she passively allows its happening.

Agent-based modeling (ABM) is one of the computational models that uses interactions among agents to understand a system as a whole. Hence, ABM, as an alternative model, is used to simulate the classroom situation because of difficulties in real classroom experiment.

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The main parts of the model are the bully and victim agents. In addition, Prisoner's Dilemma (here after PD) game is used to represent the interaction between the two agents. The similarity to PD game comes from the fact that either party can choose to defect or cooperate [4, 5]. Other researchers, [9] also uses PD game to simulate the *Ijime* situation on bystander interactions. However, this paper focuses more on the victim and bully interactions.

To compare and validate the results of the ABM model, a System Dynamics (SD) model is also developed and simulated. Development of SD model for the same phenomena, *Ijime*, has two advantages. First, it provides one independent validation model [12]. Secondly, lack of heterogeneity in SD model helps us to understand if this factor plays an important role in the macro results seen in ABM model [11].

2 Agent-Based Model

The ABM model only includes one entity which is students in a class. At each time step, each agent is assigned one of the four roles (i.e. bully, victim, bystander, and supporter). The state variables and description as well as controlled parameters are explained in detailed in the former paper by author [13].

There have been published papers in the literature that suggest the role of bully is rotated among friends in the same group [1–3]. Thus, p_i^{bully} is assumed to be uniformly distributed. In addition, the probability of becoming victim is calculated relatively within a group. There exists dynamics not only within groups but also between groups. Hence, students may change their groups at different times. When selecting group, agents use the characteristic and probability of becoming victim as criteria.

From the perspective of *Ijime*, the four cases of the game can be described as follow. (I) the case where bully cooperate means bully make little joke on victim. (II) The case where bully defects refers to when bully does *Ijime* seriously (III) The case where victim cooperates means the victim complies with bully. (IV) Finally, the case where victim defects refers to when to victim fights back.

Once assigned the roles, the bully and victim agents of each group play PD game. Afterwards, the supporter's score in each group is calculated based on the number of supporter in a group together with bully' score. This assumption appears to be consistent with intuition and the fact that they join and encourage the bully.

For calculating the bystanders' score, three cases are considered. In the case of avoiding Ijime, the bystanders' score will depend on the number of supporters as the larger number of bystanders, the more permissive and safer environment they will have. In the case of becoming helper, if the bystander is not noticed, the victim's score is increased proportional to number of helper. However, if the bystander becomes visible, the bystander will get punishment. This is to represent the severity of the inconformity. At the end of time step, the score will be normalize. Detailed explanation and formulas of the model can be found in [13]

As agents learn over time and may revise their strategies toward *Ijime* cases, they are assumed to revise their strategies at some fixed time intervals by using survival of the fittest concept [6].

3 System Dynamics Model

System dynamic model is an alternative to model social problem. Different from ABM, SD emphasizes macro approaches to model a problem [10]. In particular, SD model assumes homogeneity in the population. The advantage of SD model is a wide range of feedback effects. In this research, SD is used to verify the robustness of the model. Homogeneity in our SD model refers to conformed classroom. To build the SD model, the causal loop and stock and flow diagrams should be developed [11]. However, only casual loop is presented in this paper due to the limited space[1]. Figure 1 shows how variables affect the other variables. The flow starts from the entering rate. For model simplicity, the focus of model is on only one group. Also, the entering rate is kept constant. The entering rate affects the population of the current observed group. Then, the population will affect the score of strategies. The mean of score changes the class standard deviation of scores. Afterward, the leaving rate is modified.

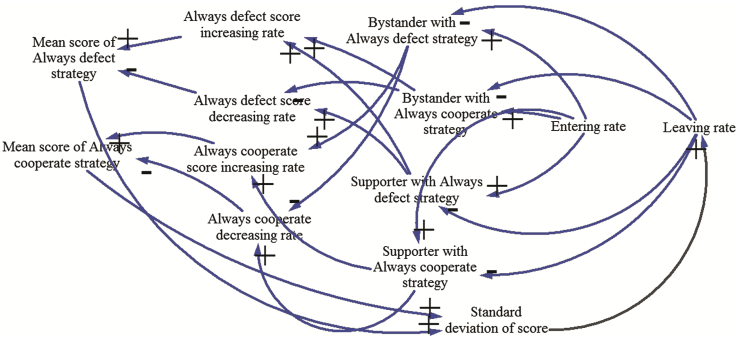

Fig. 1. Causal loop diagram (SD model)

Similar to ABM, a strategy with a high mean score shows that the strategy dominates the other strategy. In the same manner, strategies also affect standard deviation of score on all students in the group. To calculate the standard deviation of scores, the scores of students in the current group is used.

In succession, the standard deviation also affects the dynamics within the group via the leaving rate of the group. This leaving rate controls the number of students in the group. The rate becomes high as the variance becomes high as the diversity in the group would encourage students to search for more similar peers.

4 Experiments and Results

In the ABM, the simulation results are generated using the parameters defined in the ABM section of our previous paper [13]. To control randomness, one thousand simulation runs are generated. As most of the results have similar trend, the following setting

[1] Stock and flow diagram is available with author upon request.

is selected: (I) five members per group (II) supporter to bystander ratio = 0.25 (III) probability of bystander becoming helper = 0.075 and (IV) T_{sim} = 1000 ticks

Figure 2 shows the average number of agents for each strategy using ABM and the average score of each strategy respectively. According Fig. 2, "Always defect" strategy is doing better than "Always cooperate" strategy.

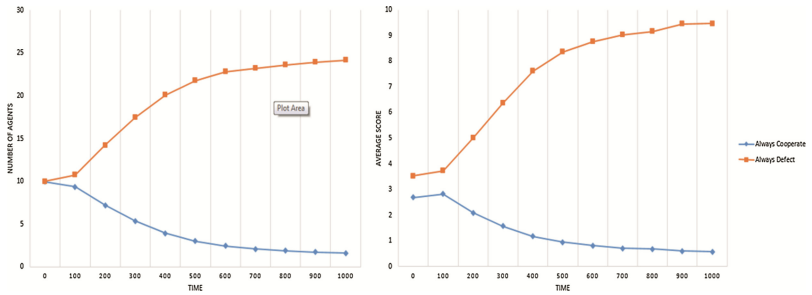

Fig. 2. Left-Average agent per strategy, Right- Average score per strategy (ABM)

Results from the SD model also yield similar phenomena. Figure 3 shows the average number of agents per strategy and the average score of each strategy respectively. Similarly, the "Always defect" strategy dominates the "Always cooperate" strategy.

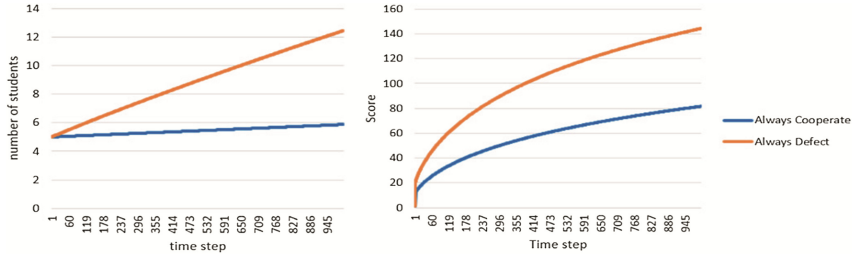

Fig. 3. Left- Agent for each strategy, Right-Score mean per strategy (SD model)

Although SD model yields similar result with ABM model, SD graph has tendency to become diverged whereas ABM graph becomes converged.

5 Discussion and Conclusion

We have developed both ABM and SD models for *Ijime* behavior with the use of PD game. The emergence can be observed through the presented graphs. The results from the experiments are also robust throughout parameters range. The generated simulation results imply the following: (I) Cooperation does not work well in this environment as defective decision becomes overwhelmed in all scenarios. This reflects current *Ijime* situation in Japan where victims are forced to cooperate with the group. This continuously put stress on the victim. Repeatedly, it can lead to serious conditions. (II) Alternatively, the victim

can disrupt the class harmony by expressing his/her feeling. The victim can gain higher social position if he/she raises up the dissatisfaction. Hence, the effects of *Ijime* can be reduced through fighting back.

The results of both models differ in both number of student and also the score of each strategy. As the ABM environment becomes converged, the SD model becomes diverged. This may stem from the fact that the SD model lacks group dynamics that exists in the ABM. Group dynamics helps pushing the student to stay in the most suitable place while the SD model only focuses at one group at a time. Despite difference, both ABM and SD model produce similar result through macro perspective modeling. The results help confirming the robustness of ABM. In a class with homogenous student, they are also encouraged to try and fight back the bully.

In summary, using an ABM, we have gained a better understanding on how to deal with *Ijime*. By encouraging the victim to be brave, we can reduce the effect of *Ijime*. Similar to any other study, we have made some assumptions/limitations in this paper. For future work, we plan to compare our model with empirical observation.

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