

## Expect the unexpected events from K12 class rooms: Some exercises studying "Power laws" with K12 students

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Power law relations, such as the Gutenberg-Richter's law or the modified Omori's law, are much familiar with seismologists. However, in K12 geoscience classes, these relations are treated neither on textbooks nor in class room exercises. The Tohoku-Oki earthquake occurred as an unexpected magnitude even for seismologist, while it could be expected statistically from the G-R law for whole Japanese Islands. During two decades, we have developed teaching materials employing power laws for example; in modifying "Go-game model (Ohtsuka,1971)" and "Sand-pile model (Bak et.al.,1989)" etc. Recently, for being designated Super Science High-school, our school made an introduction class studying "complex system sciences; eg. fractals (Mandelbrot,1977), deterministic chaos (Lorenz,1993), self organized criticality (Bak et.al.,1987)". In these classes, students can study the basis of "power laws" and the behaviors and characteristics of each model with plotting graphs and enjoying games like cellular automata. We also employed some power law examples in economics and social sciences; so called Zipf's law, including war casualties, sales of companies, markets crashes etc.. Through these exercises our students also discuss the size and frequency of such natural and social catastrophic hazards and the possibility of encountering with these events. Furthermore, the cognition bias and the confirmation bias around disasters are also going to be discussed.

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