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A Markov-based model in managing coordination relationship of school communities to achieve environmental behaviour

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Rationale

- Environment = the unity with all things, space, power, circumstances & living creatures, **including humans & their behavior** which affects human beings and any other living things (Act 23, 1997)

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WHY?

problems that plagued the world today is environmental issues, especially climate change and global warming

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Global Challenges

- *Global warming*, drastic changes in *weather* and *climate*, with impacts of *natural disasters* (e.g., *typhoon attacks*, *floods*, *tsunamis*), downsizing in *agricultural* areas, expanding *urbanization*, *pollution* of world's *natural resources*, increasing scarcity in *fresh water supplies*, etc.

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households behavior?

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Awareness? / Knowledge?

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Industries?

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Transportation?

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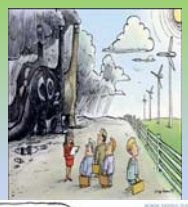

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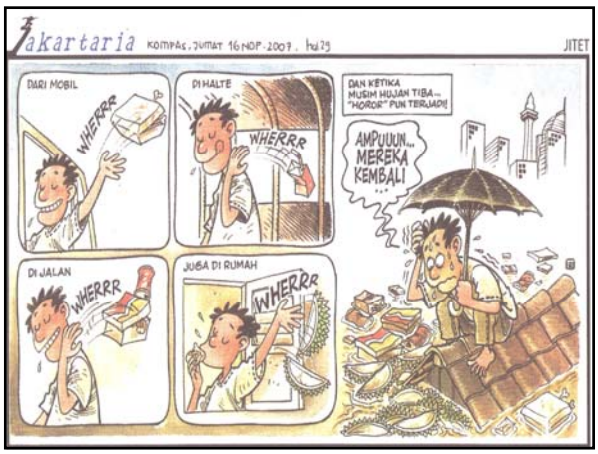

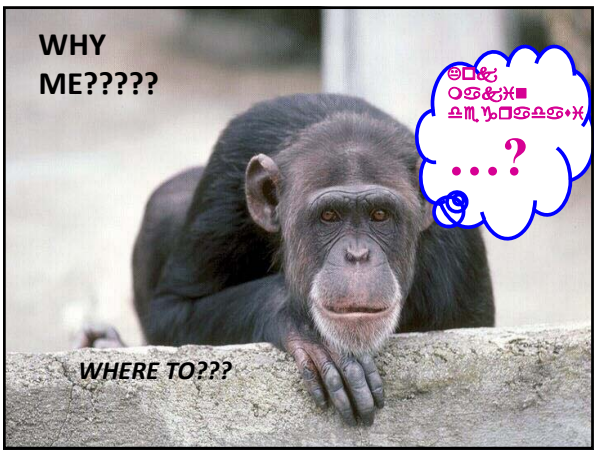

To conclude

Most of Environmental problems caused by human behavior

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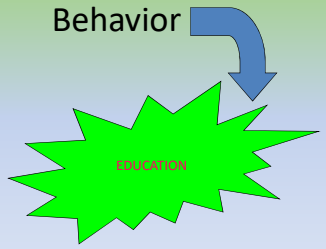
To create Environmental Behavior



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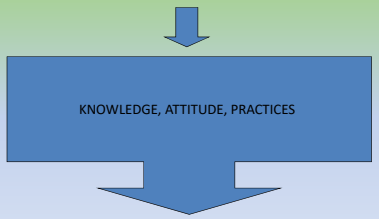
Environmental education



ENVIRONMENTAL BEHAVIOR

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SCHOOL COMMUNITY is a Multi-Agent System (MAS)

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WHY MAS?

- Because It is an agent- based model which function to simulate the operation and interaction that happened simultaneously among agents in a complex and dynamic phenomena, thus to make prediction of it.

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METHOD

DEFINITION

$POMDP_i = \langle S, A_i, T_i, \Omega_i, O_i, R_i \rangle$..... (1)

Where:

POMPDP = a partially observed Markov decision Process.

S = a set of possible states of the environment.
Ai = a set of actions agent i can execute.
Ti = transition function – $Ti : S \times Ai \times S \rightarrow [0, 1]$ which describe results of agents I's actions.
Ωi = the set of observations that the agent *i* can make.
Oi = agent's observation function – $Oi : S \times Ai \times \Omega i \rightarrow [0, 1]$ which specifies probabilities of observation if agent executes various actions that result indifferent states.
Ri = the reward function representing the agent I's characteristics $Ri : S \times Ai \rightarrow \mathbf{R}$.

(Boutilier, Dean, & Hanks 1999; Hauskrecht 2000; Kaelbling, Littman, & Cassandra 1998; Monahan 1982).

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The solution of a *POMDP* is a policy which maps the observable history of the behavior to actions

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2. Finitely Nested I-POMDPs (Interactive-POMDPs)
I-POMDPs generalize the POMDP framework to multi-agent environments (Gmytrasiewicz & Doshi 2005). Agent *i* considers the finitely nested interactive state space $IS_{i,l} = S \times M_j$ where *S* is the physical state and M_j is the set of models of agent *j* (for simplicity, we assume only two agents.) *l* is the level of nesting of *i*'s I-POMDP. These models may include models *j* could have of *i*, but are constrained to be nested to the level not greater than *l* – 1.

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Interactive Dynamic Influence Diagrams
Interactive Dynamic Influence Diagrams are a generalization of Dynamic Influence Diagrams to multi-agent settings and computational representations for I-POMDPs. They compute finite look-ahead approximations for I-POMDPs. I-DIDs contain some elements not present in classical dynamic influence diagrams

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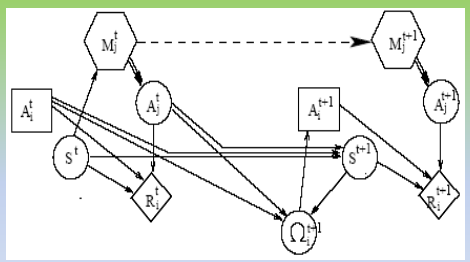

An Interactive Dynamic Influence Diagram

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Application

PARAMETER	DESCRIPTION
STATE (SI)	In terms of Environmental knowledge, supervision and motivation, planning, management, climate, academic expectation, willingness to support environmental programs
Observation (Ωi)	In terms of Awareness, evaluation, perspectives, beliefs
Action (Ai)	In terms of Instructions, efficiency , involvement in environmental programs
Knowledge (K)	in term of the principles and basic environmental education, damage and impact, school environment management, responsibility.
Attitude (A)	in term of the cleanliness, environmental education implementation, effort for environmental management, and responsibility
Practice (P)	in term of awareness, avoiding action when harmful for environment, responsibility.

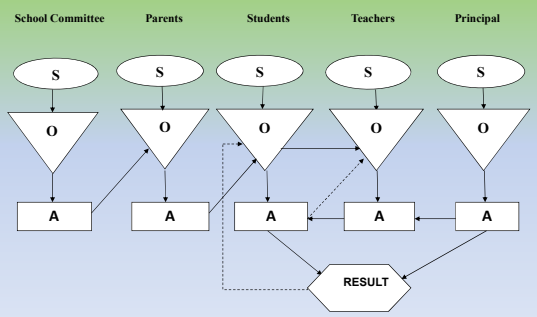
DATA

PARAMETER	DATA			
	PRINCIPLE	TEACHER	SCHOOL COMMITEE	PARENT
STATE (Si)	46,77 %	32,00	34,85	47,81
OBSERVATION (Ωi)	29,64	39,71	52,80	37,08
ACTION (Ai)	23,59	28,29	12,35	15,11

The result from where the data was taken (1st STAGE)

- **The result from the survey showed that;**
- **Parents SOA: 28.60%**
- **Committee SOA : 25.07%**
- **Teachers SOA : 23.86%**
- **Principals SOA : 22.47%**
- **Students' Knowledge K = 17, 61%;**
- **Students' Attitude A = 37, 65%**
- **Students' Practice P = 44, 74 %**

Influence Diagram of Coordination Mechanism in school communities



Probabilities Value of School Committee (as an example).

- From the diagram we need to determine the conditional probabilities of action with a condition that the observation of committee is done, i.e.,

$$P\left(A_{kom} \middle| \Omega_{kom}\right)$$

- $$P\left(A_{kom} \middle| \Omega_{kom}\right) = \frac{P\left(A_{kom} \cap \Omega_{kom}\right)}{P(\Omega_{kom})}$$

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$$P\left(\Omega_{kom} \middle| S_{kom}\right) = \frac{P\left(\Omega_{kom} \cap S_{kom}\right)}{P(S_{kom})}$$

$$P\left(\Omega_{kom} \cap S_{kom}\right) = S_{kom} \times \Omega_{kom} = 0.349 \times 0.528$$

$$P(S_{kom}) = 0.349$$

$$P\left(\Omega_{kom} \middle| S_{kom}\right) = 0.528$$

And then,

$$P\left(A_{kom} \middle| \Omega_{kom}\right) = \frac{P(A_{kom} \cap \Omega_{kom})}{P(\Omega_{kom})}$$

$$= \frac{P(Akom \cap \Omega kom)}{P\left(\Omega_{kom} \middle| S_{kom}\right)}$$

$$P(A_{kom} \cap \Omega_{kom}) = S_{kom} \times A_{kom} \times \Omega_{kom}$$

$$= 0.349 \times 0.124 \times 0.528$$

The result : $P(A_{kom} \middle| \Omega_{kom}) = 0.124 \times 0.349 = 0.043$

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the reward

$$P\left(R \middle| A_s, A_{ks}\right) = P\left(R \middle| A_s\right) P\left(R \middle| A_{ks}\right)$$

$$= \left(\frac{P(R \cap A_s)}{P(A_s)}\right)\left(\frac{P(R \cap A_{ks})}{P(A_{ks})}\right)$$

$$P(R \cap A_s) = S_s \times A_s = 0.427 \times 0.333 = 0.14$$

$$P(A_s) = P\left(A_s \middle| \Omega_s, A_g\right) = 0.08$$

$$P(R \cap A_{ks}) = S_{ks} \times A_{ks} = 0.468 \times 0.236 = 0.11$$

$$P(A_{ks}) = P\left(A_{ks} \middle| \Omega_{ks}\right) = 0.273$$

Therefore; $P\left(R \middle| A_s, A_{ks}\right) = \left(\frac{0.08}{0.14}\right)\left(\frac{0.11}{0.273}\right)$

$$= 0.57 \times 0.403$$

$$= 0.23$$

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Transitions function

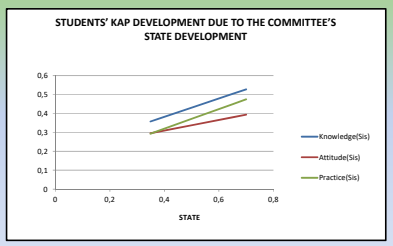
- *KAP* TRANSITIONS

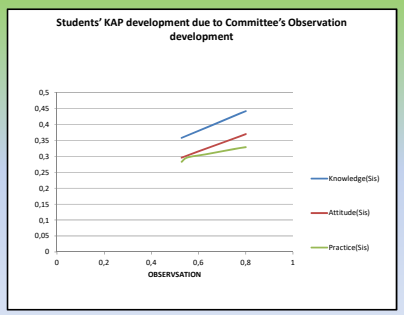
$$TR_i K = (S \times \Omega_i \times A_{ij})_k \times TR_K$$

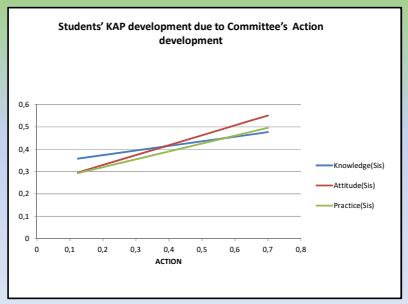
$$TR_i A = (S \times \Omega_i \times A_{ij})_i \times TR_A$$

$$TR_i P = (S \times \Omega_i \times A_{ij})_i \times TR_P$$

The Simulation of student's KAP development







The Development Values of Students' KAP

Development / Stage	*Knowledge*	*Attitude*	*Practice*
Stage 1	*17, 61*	*37, 65*	*44, 74*
Stage 2	*46, 16*	*54, 63*	*48, 63*
Development values	**28.55%**	**16.98%**	**3.89%**

Conclusion

- model has been constructed in accordance with what is expected that is a conditional form of the environmental behavior.
- It is understood that knowledge is the key to behavior change. But target behavior in this study is the environmental behavior, which can be realized from the action. Therefore the desired result is an action (implementation), which is obtained due to the occurrence of attitude, and attitudes are formed due to the occurrence of knowledge.
- In this study, the school community confirmed a weak environmental behavior.

IDEA

- Based on the result, a formula is formed to confirm environmental behavior , i.e.

$$B_e = (I_m \mid A, K)$$

- Where B_e is defined as environmental behavior which is formed by the occurrences of I_m ***(Implementation or action).***
- In the mean time, I_m can be formed due to the occurrence of Attitude (**A)** while Attitude can be formed due to the occurrence of Knowledge (**K**)