



**Advancing Practice & Horizon
Expansion of Science Education**

Empowering Scientific-Computational Action Competence for a Better Society : as Major Aim of STEAM Education

Seok-Hyun, Ga^{1,2}, Chan-Jong, Kim¹

¹ Seoul National University, Dept of Science Education

² Korea National Open University, Dept of Computer Science

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Background

Face a crisis

- ❑ We face a unexpected crisis repeatedly



Mad cow disease (1986-)



Humidifier sanitizer scandal in Korea (2011-)



COVID19 (2019-)

What makes these kind of crises? Can't we prevent these crises in advance?

Background

Humidifier Sanitizer Scandal

❑ Why are crises underestimated?



Oxy-Reckitt Benckiser
(Seller of sanitizer)

Other professor said about this report, "it is like assignment of undergraduate students."

Cho's test reports, which said, "**the causal relations between Oxy Reckitt Benckiser brand humidifier sanitizer and pulmonary illnesses are not clear,**"

He used USD 45,509 buying goods irrelevant to the research

Call for **the analysis of relation between humidity sanitizer and pulmonary illnesses** after social controversy

- USD 81,316 (research funding for SNU)
- USD 9,752 (consultancy fees for the professor)



서울대학교
SEOUL NATIONAL UNIVERSITY



Seoul National University
Professor, College of Veterinary Medicine
(Toxicology)
Cho Myung-Haeng

Background

❑ Rampant neoliberalism

- All values are converted into quantitative factors such as money.
- Treating humans as resources (Human Resources)
- Humidifier sanitizer – comparable human and money
- COVID19 – Indiscriminate Development
- President Trump – ~~America First?~~ Money First!

❑ Emerging Global Risk – Neoliberalism cannot make the solution ([The Tragedy of the Commons](#); Hardin, 1968)

- Climate Change
- Fine dust
- Refugee

How can we solve this problem?

Background

- ❑ Citizens can no longer leave their lives to experts such as politicians, scientists, and sociologists.
- ❑ Citizens who make up society should **participate in the decision-making process** through active discussion and democratic participation.



Background

Citizen Science

- ❑ However, in particular, decision-making has been dominated by experts in the science issues. **Citizens need expertise to take action** in decision making and act for change.
- ❑ Citizens should also become scientists as citizens, not as professions. In order to do that, they must have competencies that fit them.

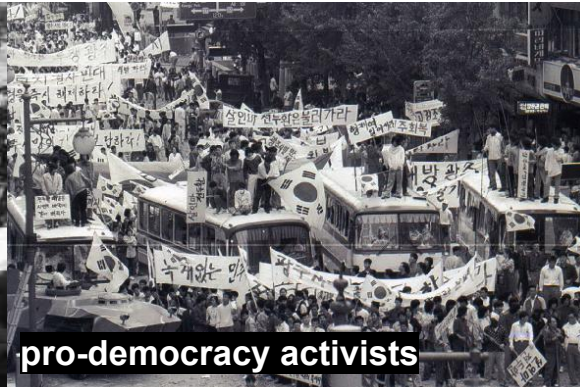
Background

From Knowledge to Action

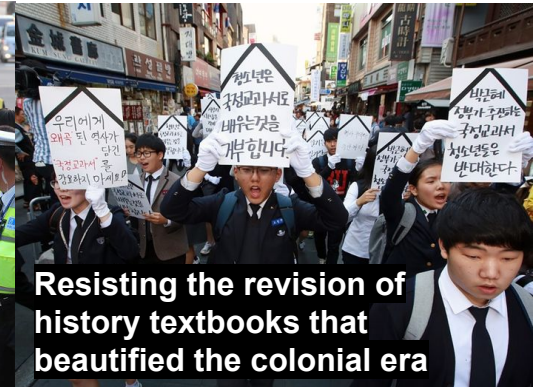
- ❑ **Activism** Students are citizens living today, not the future.
Students have to action to make better society.
≠ behavior ≠ practice



pro-democracy activists



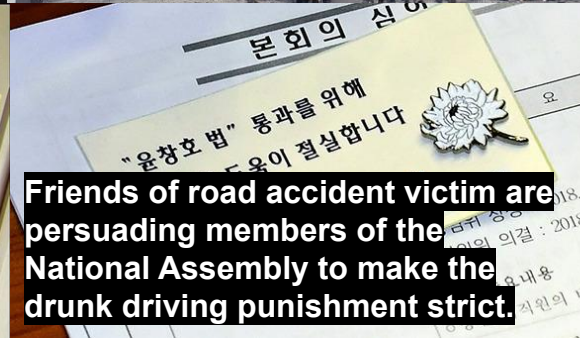
pro-democracy activists



Resisting the revision of history textbooks that beautified the colonial era



#Me too movement



Friends of road accident victim are persuading members of the National Assembly to make the drunk driving punishment strict.



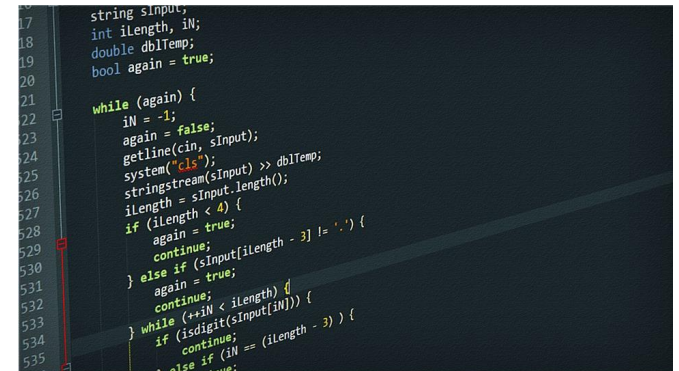
Thunberg staring at the villain



Protesting to politically biased teachers 학생 식발... "조희연 교육감 사퇴하" (Student strike... "Park Hee-yeon, Education Director, Resign")

Physical Computing for Citizen Science

- ❑ Technology is making innovative contributions to the development of citizen science (Haklay, 2018).
- ❑ Physical computing devices are digital interactive systems that **sense and react** to the physical world (O'Sullivan & Igoe, 2004)
- ❑ Through Arduino, citizens can make tools which is used for research.
- ❑ With the advent of **Arduino**, access to physical computing is much easier than ever.



What competencies students should have

❑ **Action competence**

- The action competence approach in environmental education (Jensen, 1997)
- capability – based on critical thinking and incomplete knowledge – to involve yourself as a person with other persons in responsible actions and counter actions for a more humane world (Schnack, 2000)

❑ **Activist Science and Technology Education** ⇒ **Scientific Action**

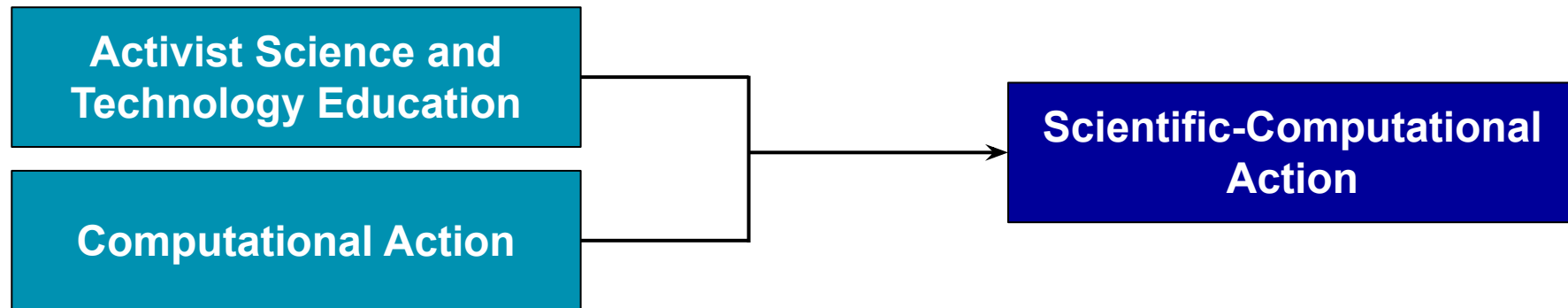
- STEPWISE (Bencze, 2017)

❑ **Maker Education, Computational Thinking** ⇒ **Computational Action**

- The computational action perspective on computing argues that while learning about computing, young people should also have opportunities to create with computing which have direct impact on their lives and their communities. (Tissenbaum, 2019)

Scientific-Computational Action

- ❑ I propose a new concept, **scientific-computational action**, that combines scientific action, related to activist science and technology education (Bencze, 2017), with computational action (Tissenbaum, 2019).
- ❑ **Scientific-Computational Action (SCA)** is an **action** to solve socio-**scientific** issues by using **computing** as a tool for making a better society[world, community].



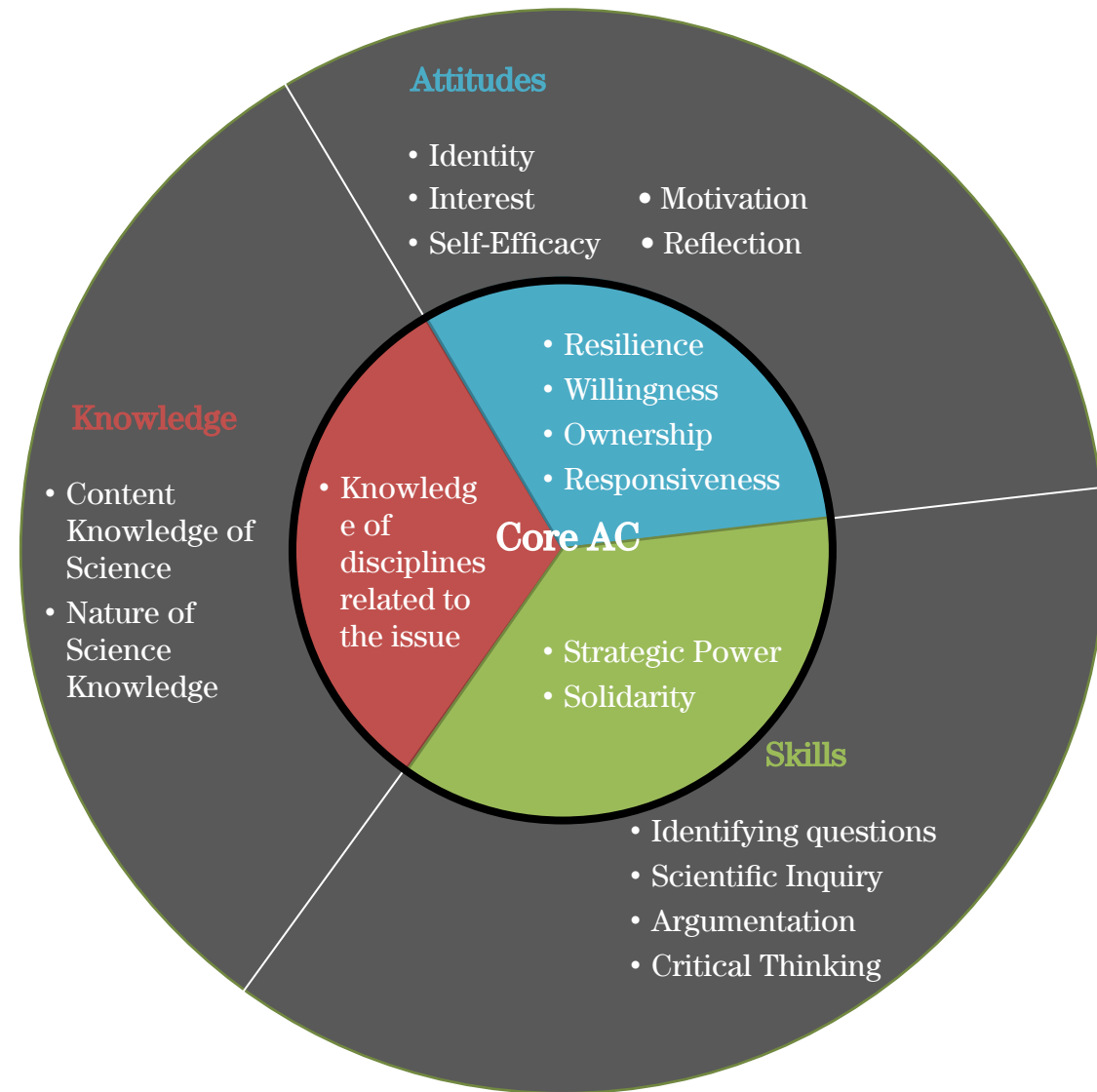
Scientific-Computational Action Competence

- ❑ **Scientific-Computational Action (SCA) Competence** is a competence to do Scientific-Computational Action.
- ❑ The background of this competence is based on Action Competence proposed by Jensen (1997).



Model of SCA Competence

- ❑ SCA are composed of three categories, **ASK** [Attitudes, Skills, Knowledges].
- ❑ Each category has several sub-elements which are divided into two parts.
- ❑ **Core AC** is the **core element** of SCA competence which is not emphasized so far.
- ❑ The outer area of Core AC is also necessary for SCA competence, but these have been already emphasized before in the science education field.



Conclusion

- ❑ In the future age, when digital devices come closer to life, it is very necessary to develop **scientific-computational action** competence to take action to change their society.
- ❑ The development of SCA competence is expected to **expand the available resources of students** in their scientific action.
- ❑ The model can help the education program developers to make STEAM education programs cultivating SCA competence.
- ❑ The model which is mentioned before is not complete, because this is made by reviewing prior researches. It needs to be revised accurately through researches in real fields.

hálás Thank you 謝謝您
Benigne! La ringrazio! Obrigado Talarxлаа Thank you
dziękuję ci serdecznie Vielen Dank Merci dík,-y!
謝謝您 Tesekkür ederim rahmat Vielen Dank
Xin da ta อนุพระคุณคุณน Terima kasih
Benigne! Obrigado dziękuję ci serdecznie
Dank U well dík,-y!
Talarxлаа 謝謝您 고맙습니다
Merci ありがとうございます Thank you
Merci ありがとうございます

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References

- Bencze, L. (Ed.). (2017). *Science and technology education promoting wellbeing for individuals, societies and environments: STEPWISE* (Vol. 14). Springer.
- Haklay M., Mazumdar S., Wardlaw J. (2018). Citizen Science for Observing and Understanding the Earth. In: Mathieu PP., Aubrecht C. (eds) *Earth Observation Open Science and Innovation*. ISSI Scientific Report Series, vol 15. Springer, Cham.
- Jensen, B. B., & Schnack, K. (1997). The Action Competence Approach in Environmental Education. *Environmental Education Research*, 3(2), 163–178. <https://doi.org/10.1080/1350462970030205>
- O’Sullivan, D., & Igoe, T. (2004). *Physical Computing* (1st edition). Thomson.
- Schnack, K. (2000). Action competence as a curriculum perspective. In B. B. Jensen, K. Schnack, & V. Simovska (Eds.), *Critical environmental and health education: research issues and challenges* (pp. 107–126). Copenhagen, Denmark: The Research Center for Environmental and Health Education, The Danish University of Education.
- Tissenbaum, M., Sheldon, J., & Abelson, H. (2019). From computational thinking to computational action. *Communications of the ACM*, 62(3), 34–36. <https://doi.org/10.1145/3265747>