Metacognitive Strategies for Gateway STEM Courses

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INTRO

- ***Metacognition:*** *awareness of one's own thought processes*
- Metacognitive monitoring is critical to performance because it allows people to reflect on their skills relative to a task
- Infusion of metacognition in gateway courses has been shown to improve student performance
- One framework for understanding metacognitive monitoring is cue-utilization
- Central and peripheral cues are predictors of difficulty people monitor while engaging in a task

Why UCM?

- Target audience that represents a more inclusive distribution of gender, ethnicity/race, and first-generation status

METHODS

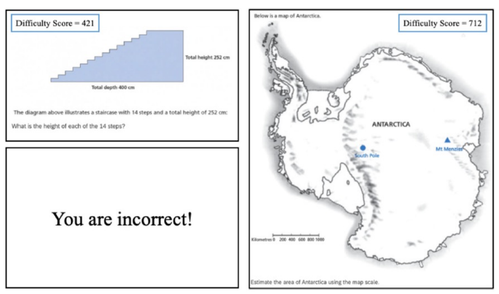
Many prompts already exist:

```
In [5]:
initAg = 0
initCl = initK = 0.1

initparams = (initAg, initCl, initK)

def AgCl_sol(concentrations):
    (Ag_conc, Cl_conc, K_conc) = concentrations

    firstEq = Ag_conc * Cl_conc - 1.82E-10
    secondEq = Ag_conc + K_conc - Cl_conc
    thirdEq = K_conc - K_conc

    return[firstEq, secondEq, thirdEq]

solution = opt.fsolve(AgCl_sol,initparams)

solubility = "{:.2E}".format(solution[0])

print("At a KCl concentration of", initK, "AgCl solubility is", solubility)
```

```
At a KCl concentration of 0.1 AgCl solubility is 1.82E-09
```

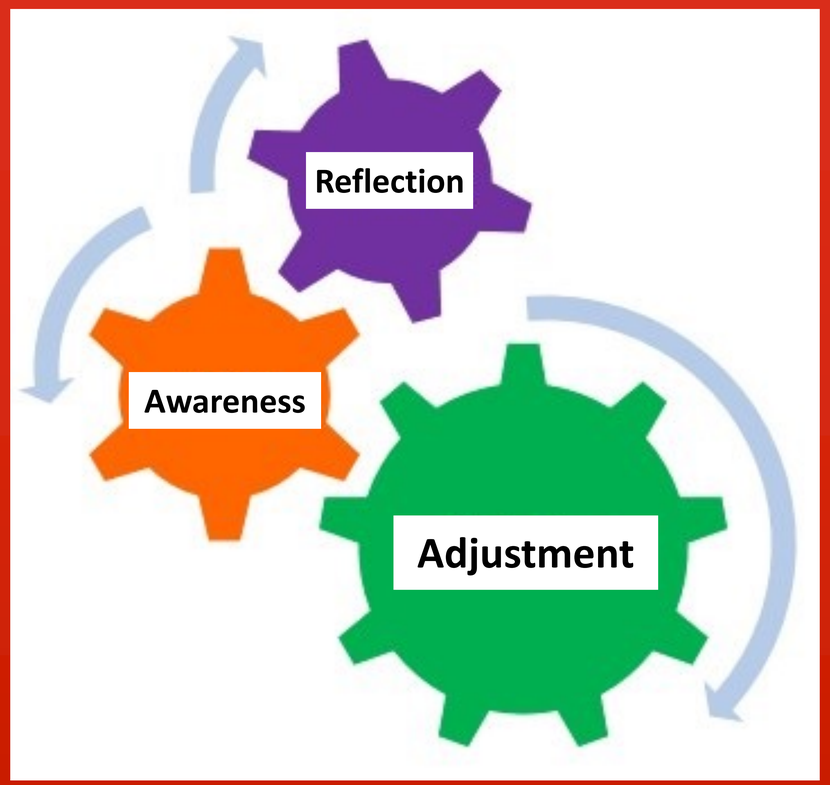
Take a look at the AgCl_sol() function that I wrote, above. Where does the first equation come from?

- LLC Jupyter notebook with prompt at end of assignment



- Question content (top left and far right) gives central cues to difficulty. Feedback (bottom left) gives peripheral cue.

Can metacognitive monitoring improve student performance in gateway courses at UC Merced?



https://thepeakperformancecenter.com/educational-learning/thinking/types-of-thinking-2/metacognition/

What are my options?

Ex. 1
- Metacognitive prompt

Ex. 2
- Metacognitive prompt

Ex. 3
- Metacognitive prompt

vs.

Ex. 1

Ex. 2

Ex. 3
- Metacognitive prompt
- Metacognitive prompt
- Metacognitive prompt

- 1st design: prompts interspersed at regular intervals
- 2nd design: prompts presented after completion of all tasks
- Which design will be a more effective facilitator of metacognitive monitoring?

ANALYSIS

- Comparing the efficacy of these two strategies may provide insight into best practices for early and advanced college learners in STEM
- Results could drive future development of combined metacognitive and active learning activities for college chemistry.

EXPECTED OUTCOMES

- First design will impair accuracy of metacognitive monitoring
- Metacognitive practices will not affect student performance immediately
- Outcome will differ for students in lower division courses compared to advanced students

FUTURE WORK

- Employ metacognitive prompt methods in lower and upper division chemistry courses
- Determine which methods are successful for which students and why
- Design Spark seminar course with Prof. Erik Menke geared toward scientific research

SUGGESTED READING

- *J. Chem. Educ.* **2020** *97* (7), 1832-1840; DOI: 10.1021/acs.jchemed.0c00254
- *Metacognition and Learning* **2021** *16*(1), 135–156.
- *Computer Assisted Language Learning* **2019** 32:1-2, 1-16; DOI: 10.1080/09588221.2018.1459729
- *J. Chem. Educ.* **2020**, 97, 10, 3899–3903; DOI: 10.1021/acs.jchemed.9b01131