Appendix 1: Scenario Instructions

Distribute the simulation place cards and value chips to the appropriate people/groups. In the scenario instructions, notations such as "**+3W**" should be read as "three white chips were paid". The letter **B** indicates blue social chips, and **R** represents red ecology chips.

To begin each scenario:

- the mining company (MC) starts with 30 W chips and 35 B chips
- the miners and other citizens start with 15 R chips each
- the government starts with no chips
- the remaining chips start with their respective banks

Scenario #1: Thoughtful Scenario

Step 1: Mining company (MC) sets up shop.

The MC invests in this operation and starts the process.

- Pays +3W and +3B to miners
- Pays +10W and +15B to the government (for permitting, promotional work, etc.)
- Pays +15W to bank (for initial capital investment)

The Social Bank

- Pays +2B to miners
- Pays +2B to other citizens for development of indirect and induced jobs in the area to support the mining operation

The Ecology Bank

- Pays +5R to MC for initial mine set up

The Economic Bank

- Pays other citizens +1W for indirect and induced jobs

Confirm that everyone has the chips they are supposed to, and understands what the next steps are.

Step 2: Mining begins

Mining starts with a fully modern mining operation and legal protections in place.

The MC:

- Pays +3W and +2B to miners
- Pays +1W and +1B to government
- Takes -5R from Ecology Bank

The Social Bank

- Pays +2B to miners

- Pays +2B to other citizens

The Ecology Bank

- Takes -1R from miners
- Takes -1R from other citizens

The Economic Bank

- Pays +15W to MC for mining products
- Pays other citizens +1W for indirect and induced jobs

Steps 3-7: Mining continues

Mining continues with a fully modern mining operation and locally legal protections in place. All payments should be the same as above for Step 2

Step 8: Assess your group's condition.

The MC:

- Do you have more money than you started with? Success!

The government:

- Do you have more money, social status and support from your constituency than before? Success!

The miners:

- Do you have more money, a higher social standing and a healthier environment than before? If the ecological capital in your area has dropped below 11 chips you cannot continue to live in your area and action MUST be taken.

The other citizens:

- Do you have more money, a higher social standing and a healthier environment than before? If the ecological capital in your area has dropped below 11 chips you cannot continue to live in your area and action MUST be taken.

Step 9: Action!

Discuss these possible actions and what the consequences may be.

The miners:

- If you are unhappy with your position, what can you do to make your situation better?
    - Attempt #1 - Money can be spent on ecological restoration. Five W chips can be spent to build back two R ecology chips. The W chips can come from citizens, the government or the MC.
    - Attempt #2 - Petition the MC - if they agree with you they will make the changes you request

    - Attempt #3 - Petition your government - if they agree with you they will control the MC.
    - Attempt #4 - Revolution

The other citizens:

- If you are unhappy with your position, what can you do to make your situation better?
    - Attempt #1 - Money can be spent on ecological restoration. Five W chips can be spent to build back two R ecology chips. The W chips can come from citizens, the government or the MC.
    - Attempt #2 - Petition the MC - if they agree with you they will make the changes you request
    - Attempt #3 - Petition your government - if they agree with you they will control the MC.
    - Attempt #4 - Revolution

The MC:

- If you have more money than you started with, you will not change your practices, content that you have "followed the law". If necessary, you will ensure the government stays in place to enforce the status quo using your financial resources.

The government:

- Did the MC enrich you with both money and status, directly and indirectly?
    - Yes? Ignore the miners and other citizens
- Do the people persist in their demands?
    - Quietly ask the MC if they will ensure you stay in power if you "enforce" the status quo
        - If the MC says "no" - bend to the will of the people
        - If the MC says "yes" - quell the rebellion with military and paramilitary forces

Throughout the simulation, the class should discuss each of these possible outcomes, why they arise, are they beneficial, what they mean for the people and groups involved, etc.

Scenario #2: Capitalist Scenario

Step 1: The Mining company (MC) sets up shop.

The MC invests in this operation and starts the process.

- Pays +3W and +3B to miners
- Pays +5W and +10B to the government (for permitting, promotional work, etc.)
- Pays +15W to bank (for initial capital investment)

The Social Bank

- Pays +2B to miners
- Pays +2B to other citizens for development of indirect and induced jobs in the area to support the mining operation

The Ecology Bank

- Pays +5R to MC for initial mine set up

The Economic Bank

- Pays other citizens +1W for indirect and induced jobs

Confirm that everyone has the chips they are supposed to, and understands what the next steps are.

Step 2: Mining begins

Mining starts with a fully modern mining operation and locally legal protections in place.

The MC:

- Pays +3W and +2B to miners
- Pays +1W and +1B to government
- Takes -5R from Ecology Bank

The Social Bank

- Pays +2B to miners
- Pays +2B to other citizens

The Ecology Bank

- Takes -1R from miners
- Takes -1R from other citizens

The Economic Bank

- Pays +15W to MC for mining products
- Pays other citizens +1W for indirect and induced jobs

Step 3, 4: Mining continues

Mining continues with a fully modern mining operation and locally legal protections in place.

Same as above for Step 2

Step 5: Mining continues, but …

Due to cost cutting motivation on the part of the MC, the modern mining operation is shifted towards "artisanal" mining practices and legal protections that were in place are ignored or grifted away.

The MC:

- Pays +1W and +1B to miners
- Pays +3W and +2B to government (The additional payments here represent dark money, bribes, etc., not put into official coffers with the original amounts)
- Takes -10R from Ecology Bank (additional value is taken from the ecology bank since governmental oversight has been restricted or removed, allowing for more ecological destruction)

The Social Bank

- Pays +1B to miners
- Pays +1B to other citizens

The Ecology Bank

- Takes -3R from miners
- Takes -3R from other citizens

The Economic Bank

- Pays +25W to MC (this is +10W than before because the MC is able to circumvent the legal and social norms from the previous step and increase production)
- Pays other citizens +1R for indirect and induced jobs

Step 6, 7: Mining continues

Mining continues with the same conditions as above for Step 5.

Step 8: Assess your group's condition.

The MC:

- Do you have more money than you started with? Success!

The government:

- Do you have more money, social status and support from your constituency than before? Success!

The miners:

- Do you have more money, a higher social standing and a healthier environment than before? Success!
- If the ecological capital in your area has dropped below 11 chips you cannot continue to live in your area and action MUST be taken.

The other citizens:

- Do you have more money, a higher social standing and a healthier environment than before? Success!
- If the ecological capital in your area has dropped below 11 chips you cannot continue to live in your area and action MUST be taken.

Step 9: Action!

Discuss these possible actions and what the consequences may be.

The miners:

- If you are unhappy with your position, what can you do to make your situation better?
    - Attempt #1 - Petition the MC - if they agree with you they will make the changes you request
    - Attempt #2 - Petition your government - if they agree with you they will control the MC.
    - Attempt #3 - Revolution

The other citizens:

- If you are unhappy with your position, what can you do to make your situation better?
    - Attempt #1 - Petition the MC - if they agree with you they will make the changes you request
    - Attempt #2 - Petition your government - if they agree with you they will control the MC.
    - Attempt #3 - Revolution

The MC:

- If you have more money than you started with you will not change your practices
- You will work to ensure the current government stays in power through your continued illicit financial support if asked.

The government:

- Did the MC enrich you with both money and status, directly and indirectly?
    - Yes? Ignore the miners and other citizens from Attempt #2 above.
- Do the people persist in their demands?
    - Are the people above in active revolt against the MC? Yes? See below.
    - Quietly ask the MC if they will ensure you stay in power if you "enforce" the status quo
        - If the MC says "no" - bend to the will of the people and enforce the laws initially agreed upon.

- If the MC says “yes” - quell the rebellion with military and paramilitary forces

The class should discuss each of these possible outcomes, why they arise, are they beneficial, what they mean for the people and groups involved, etc.

Scenario #3: Sustainability Scenario

The various stakeholders will collaborate and come to a solution to ensure the development of the mineral resource while maintaining ecological and social sustainability within the system. Reflect on the previous scenarios and build a robust, sustainable model based on previous experiences. It may be helpful for each stakeholder group to reflect on their positionality within the simulation. Working to understand the motivation of each group is important, especially if participants do not hold the same worldview as a particular stakeholder group. This mental work will help build learner confidence by interacting with each of the sustainability competencies.

Bringing outside ideas or ideologies to the conversation can build rapport and buy-in from other groups. For example, if representing the other citizens' stakeholder group, one could bring the idea of "doughnut economics" to the conversation and discuss how viewing the whole economic system through the typical lens of linear consumption is unsustainable and harmful to their group, while other groups benefit. Additional discussion about how to scale doughnut economics to local levels could be useful in generating buy-in from other stakeholder groups (Turner & Wills, 2022). Offering different perspectives and answers will likely aid the overall group in finding sustainable solutions.

Checking within and between each group as conversations progress to highlight the relevant sustainability competencies and SDGs may help to synthesize solutions with sustainable outcomes. For example, if a possible solution is presented, ensure that each group is checking that the solution is not counter to relevant SDGs, and understand how the solution fits within the competency framework. Is it a systems-level fix? Make sure the tenets of the SDGs are maintained and it is understood and explained to the whole group how systems thinking is relevant and promoted by the solution.

Assume all of the "costs" will remain the same as in previous scenarios; however, negotiate where appropriate. Example: The Economic Bank will only provide the "market" price for the minerals so that is not a negotiable point (15W per step for a managed system, 25W for unmanaged). Likewise, the cost of ecological restoration is the same ratio of 5W:2R. Negotiable points, for example, could be where the stakeholders collaborate and develop an agreement in which the mining company pays a share of their profits for ecological restoration to prevent ecological collapse. Mid-course corrections or modifications are also possible during this scenario; as in real-life, if things are not working and need to be re-evaluated or changed after a round or two, be empowered to do so!

Appendix 2: Simulation Place Cards

Each Bank (Social, Economic and Ecology) and Stakeholder (Mining Company, Government, Miners, Other Citizens) place card should be printed off on individual sheets of paper and distributed to the students representing each group.

Social Bank

START

5 value chips 1 value chips

Step:

1	**2**
3	**4**
5	**6**
7	**8**

Economic Bank

START

10 value chips 1 value chips

Step:

1		**2**
3		**4**
5		**6**
7		**8**

Ecology Bank

START

5 value chips | 1 value chips

Step:

1	**2**
3	**4**
5	**6**
7	**8**

Mining Company

START

The Mining Company starts with:

30 Money chips 35 Social chips

Step:

1	**2**
3	**4**
5	**6**

7		**8**

Government

START

The government starts with no chips.

Step:

1		**2**

3		**4**

5		**6**

7		**8**

Miners

START

The miners start with: 15 Ecology chips

Step:

1		**2**
3		**4**
5		**6**
7		**8**

Other Citizens

START

The Other Citizens start with: 15 Ecology chips

Step:

1		**2**
3		**4**
5		**6**
7		**8**

Appendix 3: Assessment Resources

Assessment:

Assessing student learning of sustainability competencies during this simulation activity can be accomplished using the provided grading rubric for the simulation and self-reflection questions.

Overall Quality of Sustainability Interactions	**Exceeds Proficiency**	**Proficient**	**Somewhat Proficient**	**Not Proficient**
Sustainability Competency	4 points	3 points	2 points	1 point
Systems thinking	Demonstrates superior understanding of, and ability to analyze complex systems across different domains and scales.	Demonstrates the ability to analyze complex systems across different domains and scales.	Demonstrates some ability to analyze complex systems across different domains and scales, but needs work to build analytical skills and mental flexibility.	Demonstrates poor understanding of complex systems. Reliance on focus on single/few issues to formulate strategies.
Futures thinking competency	Demonstrates superior ability to craft rich "pictures" of the future to inform sustainability actions during the simulation. Utilization of imagination and critical thinking skills to develop logical predictive models of future outcomes in the simulation, based on possible actions and past experiences.	Demonstrates ability to craft rich "pictures" of the future to inform sustainability actions during the simulation.	Demonstrates some ability to craft "pictures" of the future to inform sustainability actions but needs to develop imaginative, critical thinking and predictive skills to better predict possible outcomes.	Demonstrates poor ability to craft rich "pictures" of the future to inform sustainability actions. Demonstrates a lack of ability to meaningfully plan ahead.
Values thinking competency	Demonstrates superior ability to understand and negotiate sustainability values, principles, and goals. Shows empathy and understanding throughout the simulation, especially to stakeholders with different viewpoints.	Demonstrates ability to understand and negotiate sustainability values, principles, and goals.	Demonstrates some ability to understand and negotiate sustainability values, principles, and goals. Must develop open mindedness to see and respect different perspectives that may be contrary to personal beliefs.	Demonstrates poor ability to understand and negotiate sustainability values, principles, and goals Demonstrates an unwillingness to understand new perspectives.
Strategic thinking competency	Demonstrates superior ability to design and implement transformative strategies towards sustainability outcomes. Ability to creatively plan strategies for sustainability.	Demonstrates ability to design and implement strategies towards sustainability outcomes.	Demonstrates some ability to design and implement strategies towards sustainability outcomes.	Demonstrates poor ability to design and implement strategies towards sustainability outcomes. Generally lacking strategic planning skills.

Interpersonal competency	Demonstrates superior ability to motivate and facilitate collaborative sustainability problem solving. Exceptional empathy, interpersonal understanding, collaboration, and communication skills.	Demonstrates ability to motivate and facilitate collaborative sustainability problem solving.	Demonstrates some ability to motivate and facilitate collaborative sustainability problem solving. Needs to work on interpersonal skills to enhance learning outcomes.	Demonstrates poor ability to motivate and facilitate collaborative sustainability problem solving. Unwilling to effectively collaborate in problem solving.
Integrated problem-solving competency	Demonstrates superior ability to combine and integrate sustainability problem-solving processes, utilizing varied and relevant ways of knowing.	Demonstrates ability to combine and integrate sustainability problem-solving processes.	Demonstrates some ability to combine and integrate sustainability problem-solving processes. Needs to develop additional integrative problem solving skills.	Demonstrates poor ability to combine and integrate sustainability problem-solving processes.
Intrapersonal competency	Demonstrates superior ability to reflect and express internal emotions and motivations. Ability to express how internal mindset influenced the simulation and interaction with others.	Demonstrates ability to reflect and express internal emotions and motivations.	Demonstrates some ability to reflect and express internal emotions and motivations. Needs to develop additional self-awareness and expression skills.	Demonstrates poor ability to reflect and express internal emotions and motivations.
Implementation competency	Not assessed	*Note This competency is beyond the scope of this activity.		

The intrapersonal sustainability competency can be assessed with the self-reflection activity.

Simulation Student Self Reflection

Understanding one's own positionality and values is an important component of learning for sustainability related issues. The intrapersonal competency links to the other competencies much the same as the interpersonal competency and provides the values, mindset and inspiration leading to application of sustainability competencies (Brundiers, et al. (2021).

For the following questions please provide full and thoughtful answers.

Reflect on your own experiences during this simulation. What emotions did this simulation excite in you? Why?

Prior to this simulation, what opinions/ values did you possess about sustainability? Were you able to express these values and opinions during the simulation? Why or why not?

- If you were in a position to act as a stakeholder that may be motivated differently than you, personally, reflect on how that made you feel. Did it expand your learning, or did you find it stifling to your creativity?

- If you were in a position to act as a stakeholder that shared your personal motivations, reflect on how that made you feel. Did it expand your learning, or did you find it stifling to your creativity?

How did you feel about other stakeholders during this simulation? Were you able to be self-aware and able to self-regulate your emotions and feelings towards others during the simulation? Describe

Project this situation into your own life. Who or what organizations in your life might be represented by the "Mining Company"? Where do you think you "fit" in your situation? Where would you want to be?

What other thoughts, emotions, and lessons did you experience during this simulation?