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Water, M&M, and Economic Thinking

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Abstract

This paper presents a learning module called “Water and M&M,” which aims to promote economic literacy and entrepreneurial mindset in engineering education. The activity uses a one-minute video sketch depicting an unusual transaction between two people. In the activity, students first review and explain selected basic principles of economics before analyzing the transaction through scaffolding. Working in small groups, they discuss efficiency and fairness, identify real-life examples of similar transactions, look for value-creation opportunities, and consider the role of governments in the market economy. The module is designed to introduce economics to engineering students innovatively and entertainingly. It also fosters an entrepreneurial mindset by infusing curiosity, creativity, and connection-making into the curriculum. Emerging evidence of the case study's effectiveness is based on student perceptions and teaching reflections of instructors who implemented the activity. By introducing the activity and lessons learned, this paper significantly contributes to promoting economic literacy in engineering education.

Keywords: Principles of economics, economic literacy, entrepreneurial mindset, teamwork.

Background and Motivation

Economics can often feel foreign to non-majoring students, particularly engineering students. Yet, economics, society, and engineering are intertwined. In engineering education, accreditation bodies like the Accreditation Board for Engineering and Technology (ABET) encourage the integration of economic considerations throughout the engineering curriculum, suggesting that economic principles and analysis may be incorporated into various courses and projects for engineering students. Programs such as civil engineering include an explanation of concepts and principles in project management and engineering economics in student outcomes [1]. The curriculum must explain some, but not necessarily all, of the key concepts and principles, and there is no obligation to assess students' ability to explain the key concepts and principles.

Most undergraduate engineering programs introduce economics through a complete course like engineering economics. These courses often focus on the evaluation of the benefits and costs of alternatives to some aspects of an engineering project [2], [3], with too much emphasis on calculations and less on economic intuition and thinking. Similarly, typical introductory economics courses do not naturally attract engineering students, even though economics is in our daily lives [4]. This could explain why 74% of students who began college in 2012, including engineering students, never took economics [5].

I argue that the Water and M&M module is a low-cost approach to introduce economic thinking into engineering education and can encourage students to further their learning of economics. This problem-solving module is designed to help students become more curious about economics and connect economic principles with their lives and careers in an entertaining way. Alfred Marshall, a pioneer in economics, said, "Economics is a study of mankind in the ordinary business of life." Back in 1917, John F Hayford wrote an article to explain the relation of engineering to economics with some concrete and practical illustrative examples[6]. The goal of this problem-solving studio module is to use basic principles of economics (e.g., [7]) to analyze the transaction beyond first impressions.

The "Water and M&M" module relies instead on a set of core economic principles to cover some of the most important concepts. Learning these core concepts is important for students who may not be able to learn or otherwise never get exposed to a full economics course. Furthermore, the module combines the use of case studies with collaborative learning. Case studies allow for real-world scenarios to contextualize economic concepts, while group work and discussions promote deeper engagement. This is important for engineering education as engineering and economics are intertwined [6], [8].

This paper presents the "Water and M&M" module to motivate students to learn economics by using situations relevant to them. Making economics relevant and entertaining improves student engagement and learning. The literature on gamified learning [9] and student engagement [10] supports why this activity can be effective. Gamifying learning or implementing game-like elements into learning activities can increase the motivation and engagement of learners [11], [12].

The module relies on a video sketch that depicts an unusual transaction between two people who traded a bottle of water for a house due to a sudden water scarcity. The activity helps students review the basic principles of economics and analyze the transaction critically by using basic principles of economics. Eventually, students, working in small groups, answer questions such as explaining the difference between efficiency and fairness, identifying some real-life examples of similar transactions, and discussing the role of governments in the markets. The activity relies on students' curiosity about and familiarity with the situation depicted in the video to promote economic thinking and economic literacy through problem-solving.

Though the activity does not use game mechanics like points, badges for achievements, or leaderboards to foster competition among participants, it does incorporate game dynamics through the emotional or psychological responses related to a sense of accomplishment or community recognition, which can motivate students further [13].

Requiring students to research and share real-life examples and explore opportunities for government interventions and regulations to achieve efficiency or fairness encourages them to engage more deeply with the basic principles. Based on student perceptions and reflections from instructors, there is emerging evidence of the effectiveness of this learning strategy. The paper presents the framework and the learning activity, discusses the benefits to students, and shares lessons learned with other instructors interested in using similar learning strategies in their classrooms.

The Water and M&M Problem-Solving Module

Course Context

The module has been implemented in introductory economics courses, notably introductory microeconomics and introductory macroeconomics at a small engineering school in the Northeastern United States. The courses were delivered over a 7-week academic period. Each economics class enrolled on average 60 undergraduate students. Students in these classes are exposed to the module at various times of the academic period, in the first two weeks, in the middle, or toward the end of the period. During the activity, students work in groups of 4-6.

Learning Objectives

Students who engage in this activity will be able to:

- Review and apply basic principles of economics
- Analyze a trade transaction
- Explain the difference between efficiency and fairness
- Discuss the role of governments in markets.

Logistics

Class time needed: 45-60 minutes, including:

- 15-20 minutes to review key principles
- 20-25 minutes of student work
- 10-15 minutes to debrief and conclude

Material Needed:

- PowerPoint slides for the activity
- Group worksheets (one for each group of students) – See Appendix 1
- A feedback survey like the Critical Incident Questions (One for each student) – See Appendix 2
- Optional: A bottle of water, M&M, and a gingerbread/toy house to serve as props

Implementation

Students are asked first to review Mankiw's Ten Principles of Economics [7]. Then, they watch the following video: https://youtu.be/kt5Vsr6OBwY

After students work individually for 5 minutes on answering the question: "*Was the outcome of the transaction described in the video efficient or fair?*", they continue their discussions in groups of 4-6 for 15 minutes.

The instructor scaffolds the question after the students have discussed it for 3 minutes. The following questions may be used to scaffold:

- Identify 3 key economic principles at stake
- What is the opportunity cost of a water bottle?
- What is the opportunity cost of the house?
- Who benefits from the transaction?
- Is the outcome efficient? Is it fair?

The five questions above serve as the basis for the teamwork portion of the activity (See Group Worksheet in Appendix 2)

Tips for Instructors Using the Water and M&M Module

This activity is more successful when students are somewhat familiar with Mankiw's Ten Principles of Economics [7]:

#1 People face tradeoffs
#2 The cost of something is what you give up to get it
#3 Rational people think at the margin
#4 People respond to incentives
#5 Trade can make everyone better off
#6 Markets are usually a good way to organize economic activity

#7 Governments can sometimes improve market outcomes
#8 A country's standard of living depends on its ability to produce goods and services
#9 Prices rise when the government prints too much money
#10 Society faces a short-run tradeoff between inflation and unemployment

It is helpful for students to be familiar with the 10 principles for the success of this problem-solving activity. Before students watch the activity video, the instructor can facilitate a review of the key principles by asking them to work in pairs or small groups to:

- Choose 2 of the principles
- Explain in your own words each principle
- Provide one example to illustrate each principle.

For students to view the video with purpose, it is recommended that the instructor engage them with the following statement before showing the video: "*You will watch a 2-minute video and analyze the content like an economist. As you view the video, please consider the following question:* ***'Was the outcome of the transaction described in the video efficient or fair?' "***

The section "Expected Discussions and Notes for Instructors" discusses what to expect from students and offers some examples of scenarios and how to address them when guiding students in solving the problem.

At the end of the activity, the instructor can use a feedback form like the CIQ survey in Appendix 2 to gather student reflections and feedback on the activity. Their feedback helps the instructor make future iterations of the activity more effective in achieving the learning objectives.

A Literacy-Target Approach to Teaching Economics

An alternative to relying on Mankiw's ten principles of economics is that instructors may choose to limit the discussion to selected core economic principles, such as:

- Scarcity and choice
- Opportunity cost and tradeoff
- Incentive
- Benefit-cost analysis
- Marginal analysis
- Efficiency
- Utility or profit maximization

Targeting these key economic concepts and principles is consistent with the literacy-targeted (LT) approach to teaching economics. Proponents of this "literacy-targeted" approach emphasize the value of the ability of students to apply a few economic concepts over their exposure to a wider range of concepts easily forgotten over time. Therefore, LT approach focuses on a short

list of core concepts that students can use in real life [14], [15], [16]. Robert Frank, for example, suggests the following:

> *The scarcity principle: Having more of one good thing usually means having less of another.*
>
> *The cost-benefit principle: Take no action unless its marginal benefit is at least as great as its marginal cost.*
>
> *The not-all-costs-matter-equally principle: When making decisions, some costs (e.g., opportunity and marginal costs) matter much more than others (e.g., sunk and average costs).*
>
> *The principle of comparative advantage: Everyone does best when each concentrates on the activity for which he or she is relatively most productive.*
>
> *The principle of increasing opportunity cost: Use the resources with the lowest opportunity cost before turning to those with higher opportunity costs.*
>
> *The equilibrium principle: A market in equilibrium leaves no unexploited opportunities for individuals but may not exploit all gains achievable through collective action.*
>
> *The efficiency principle: Efficiency is an important social goal because when the economic pie grows larger, everyone can have a larger slice.*

Student Perceptions & Instructor Reflections

During the 2022-2023 academic year, the author and three other instructors implemented this learning module in their economics courses, collected the CIQ surveys from more than 200 students, and shared their teaching reflections after the implementation. Based on instructors' reflections and students' initial perceptions, emerging evidence indicates the effectiveness of the activity in promoting student interest and learning. Students were engaged in group discussions and frequently requested additional time after the 15-minute limit to continue discussing the questions. There is also anecdotal evidence of students requesting access to the video sketch months after the course has concluded, suggesting their continued interest in the economic principles discussed in the module.

Expected Discussions and Notes for Instructors

This section provides a summary of the main video for the activity and discusses some answers to the main questions.

A Summary of the video

In the video, a friend (Joe) got back and noticed that only M&M candies would flow from the water faucets in their house instead of water. Intrigued, they call their friend to the rescue. This friend (Jack) happens to have two bottles of water and is willing to trade. Eventually, they traded one water bottle for the deed of the house.

Initial Reactions from Students

Initially, most students would point to the fact that the transaction was unfair and that the water owner ripped off the homeowner. In general, most of them don't even think about the question of efficiency.

Entrepreneurial Mindset.

An entrepreneurial mindset is a way of thinking that includes attitudes, habits, and behaviors that facilitate problem-solving, innovation, and value creation [17]. The Water and M&M module taps into the entrepreneurial mindset of students by leveraging the three Cs: Curiosity, Connections, and value Creation. Their curiosity of students is engaged when they become inquisitive about the video. They make connections by integrating what they learn from the economic principles with what they see from the transaction depicted in the video. Finally, they are invited to create value by becoming mindful of real-life situations where economic thinking is useful.

Discussions

The instructor can review the scaffolding questions, as summarized below:

<u>Principles at work</u>

As students start reviewing the basic principles, they quickly realize that many of the principles apply, such as:

- **#1 People face tradeoffs:** Jack the homeowner faces the tradeoff.
- **#2 The cost of something is what you give up to get it:** To Jack, a single water bottle in this situation is worth the house. That is why he was willing to trade the bottle for the house.
- **#4 People respond to incentives:** Though Jack only has 2 water bottles in this difficult situation, he was willing to trade one of them because of the incentive offered by Joe, who proposed his house deed in return.
- **#5 Trade can make everyone better off:** At the end of the trade, it was clear from the video that Joe was relieved to have a bottle of water to enjoy, and Jack was happy to have helped his friend and got a house in return.
- **#6 Markets are usually a good way to organize economic activity**: This mutually beneficial trade would not have happened without the opportunity of trading allowing the outcome to be efficient.

<u>Assessing the transaction</u>

Most students can have an idea of what the water bottle is worth. However, in spite of their guess that the house value is larger, they don't know exactly its value. The instructor can encourage them to research online the value of the house.

This search will prompt their creativity as they will need to use their entrepreneurial mindset [17] to understand that the value of the house will depend on the area or zip code where the transaction happens. The instructor can ask students to use the zip code of their university to value the house and a water bottle, values they will use to calculate the opportunity costs and determine the patterns of trade.

Fairness and Incentive

The fact that Joe offered on their own to trade their house for the bottle of water suggests that in that moment, the water bottle is worth at least as much as the house, assuming that Joe is rational, meaning that they cannot do anything that makes them better off. This suggests that Joe has an ***incentive*** to trade their house for a bottle of water. The instructor can ask students to discuss what some of the incentives might be for the other party, Jack.

Finally, students can understand from this discussion another principle: ***"Trade can make everyone better off."***

From that point of view, the trade is fair since each of them finds it beneficial to trade.

Efficiency

The instructor can use this opportunity to remind students about the concept of efficiency before applying it. The efficiency of the market is what is expressed in the principle ***"Markets are usually a good way to organize economic activity."***

Government Interventions

Many students would point to the possibility for the government to intervene through price control (e.g.: a price floor for the house to ensure that the homeowner receives a minimum revenue) in this market to address what they perceive as unfairness.

A discussion of government interventions can point out that, in general, they can improve efficiency or fairness, but they can also make a situation work. The discussion can use situation when government interventions can improve efficiency such as in the case of externalities, and when they can worsen society's welfare such as with excise taxes or price control.

Real-Life Examples

Some examples can be found in various areas of life when life decisions are taken, such as:

- In extreme health situations, some people sell their houses to access critical health care, trading their shelter for an opportunity to live.
- A mother selling their house to send their child to college or to fund a child's engineering invention.

Students should be able to find similar examples in articles/stories in the press or online. They can then think about the opportunities the situations present, for example, by finding alternative solutions to these situations, thereby creating value.

Concluding Remarks

The paper presents a learning module that introduces economic thinking to engineering using a thought-provoking scenario. The activity stimulates students and engages them in the application of basic principles of economics to the world around them. It also taps into the entrepreneurial mindset of students by leveraging their curiosity, encourages them to integrate what they learn from the economic principles with what they see from the transaction depicted in the video, and invites them to create value by becoming mindful of real-life situations where economic thinking is useful. The paper contributes to the literature on promoting economic literacy to engineering students by combining the entertaining value of the game-like video with the effectiveness of collaborative learning. Future work can consider more quantitative analysis of the effectiveness of the learning module in promoting economic literacy in engineering education.

Conflict of Interest

There is no conflict of interest to the authors' knowledge.

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Appendix 1: Water and M&M – Group Worksheet

Please write your team's answers and return this to the instructor at the end of the activity

1. Identify 3 key economic principles at work.

2. Was the outcome of the transaction efficient? Was it fair?

3. Are the stakeholders behaving rationally?

4. Discuss how a government intervention may help or hurt the situation.

5. Identify a real-life example of a similar ultimate transaction. What opportunities may this example offer?

Appendix 2: Critical Incident Questionnaire (CIQ)

Please take a few minutes to answer the following questions about this activity.

Don't put your name on this – your responses should be anonymous. Thanks for taking the time to do this. What you write will help me make the activity more effective in achieving the learning objectives.

1. At what moment in the activity did you feel most engaged with what was happening?

2. At what moment in the activity did you feel most distanced from what was happening?

3. What action or idea that anyone took or shared (professor or student) in the activity so far did you find most affirming or helpful?

4. What action or idea that anyone took or shared (professor or student) in the activity did you find most puzzling or confusing?

5. What about the activity so far has surprised you the most? (this could be something about your own reactions to what went on, or something that someone did, or anything else that occurs to you).