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## **Supporting Quantitative Habits of Mind with Role-Play**

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**Abstract:** To support business, health professions, and social work students develop certain habits of mind, including incorporating data in their arguments, identifying agendas that may be behind seemingly objective arguments, and considering ethical quantitative communication, we developed a role-playing game built around a budget crisis at a rural health clinic. In the game, students take on roles described in character sheets, each with their own victory conditions. Characters are grouped in teams, or “factions,” with faction-level victory conditions. As a class, the students must solve the budget crisis by finding appropriate cuts to make. In their factions, students develop arguments to make cuts that support their victory conditions. They present their arguments to the class, and students vote on budget proposals. The game is used to introduce a quantitative reasoning course that was designed by an interdisciplinary team for students in service-oriented majors.

### **Introduction**

#### ***Numeracy, Quantitative Literacy, and Quantitative Reasoning***

Numeracy, quantitative literacy, and quantitative reasoning are critical skills for a 21<sup>st</sup> century democracy (Steen, 2001). While these terms can be parsed and carefully defined (Karaali et. al., 2016; Fisher, 2019), we will focus on what all these terms have in common: habits of mind. Habits of mind generally are dispositions towards behaving intelligently when confronted with problems the answers to which are not immediately clear (Costa & Kallick, 2000).

The habits of mind related to quantitative reasoning can be summarized as a willingness and tendency of an individual to, on their own initiative, incorporate data into their everyday and professional investigations into the world around them. (Stuart & Klyve, 2013). Content in quantitative reasoning courses can vary. Some of the most common content areas include proportional reasoning, probability and statistics, and modeling – all with an emphasis on spreadsheets (Gaze, 2019). What is critical is the rich contextualization of the quantitative skills involved (see, e.g., Gaze, 2014). It should also be noted that teaching such skills is not the exclusive domain of mathematics faculty (Madison, 2019). In addition, these habits of mind are not only needed in the population at large, they are also necessary for STEM students – as conversations between mathematics faculty and STEM partner disciplines noted (Ganter & Barker, 2004). For our purposes, we will use the term “quantitative reasoning” to include these quantitatively oriented habits of mind together with the skills needed to support such habits, with an emphasis on the habits themselves.

#### ***Role-Playing Games and Quantitative Reasoning***

Game-based learning is a natural fit for those wishing to teach quantitative reasoning. Games create learning experiences in which students engage with tasks that involve both repeated practice of skills and the development of the dispositions to use those skills (see generally Egenfeldt-Nielsen, Meyer, & Sørensen, 2011). Fisher et. al. (2019) developed a board game designed to teach New York City students proportional reasoning within the context of gentrification in their neighborhoods. Curran et. al. (2012) created a role-playing game based on congressional debates over the Social Security Act in 1935.

Role-immersion and role-playing games are particularly powerful. The game described in this paper was modeled after those developed by Reacting to the Past (<https://reacting.barnard.edu/>) (RTTP), a consortium dedicating to support role-playing pedagogy in higher education. RTTP games are based in historical contexts. As described on the website, students are assigned character roles with specific goals (or “victory conditions”). They are grouped together into teams, or “factions,” with common interests and goals. Students must effectively argue and collaborate in order to meet their victory conditions, with the pedagogical objective of engaging directly with big ideas and primary source texts.

Role-playing games inspire the kind of engaging environment that supports the development of habits of mind (Carnes, 2018). Authors have found that RTTP games are effective for diverse purposes. Albright (2017) and Gasper-Hulvat (2018) found that RTTP was effective at engaging students in a course they may not have otherwise had interest in and reducing anxiety surrounding more traditional educational experiences. Joyce, Lamey, and Martin (2018) found RTTP effectively improved students’ analysis, evaluation, communication, and argumentation in philosophy courses. More generally, Stroessner, Beckerman, and Whittaker (2009) found that role-playing educational games such as RTTP improve student self-esteem and empathy, self-efficacy, and belief that human characteristics can grow. These findings indicate the potential for RTTP-inspired role-playing games to lay a necessary foundation for quantitative habits of mind.

### ***Institutional Context***

Ferris State University (Ferris) is a 4-year regional comprehensive public university located in Big Rapids, Michigan. Ferris typically serves populations that are less prepared for college, and functions as the regional community college in addition to serving as a university. A large portion of the student population is first-generation. The mission of the university is career oriented. In short, Ferris serves to provide a bridge for students from poverty, primarily but not exclusively rural, to the middle class.

To meet this mission, the mathematics department developed a course entitled Quantitative Reasoning for Professionals. The goal of the course is to situate quantitative reasoning habits of mind within professional contexts. Originally designed for business (Piercey & Militzer, 2017), the course differs from typical quantitative reasoning courses in that students are thought of as producers and communicators of quantitative information, as opposed to consumers such as readers of the news (see, e.g., Paolos, 2013; Madison et. al., 2012). The implications of this framework are that the content of the course includes more algebra than typically expected (see Piercey, 2017) and addresses ethical issues that arise with the responsibilities entailed in such a role (see Piercey, 2019).

With funding from the National Science Foundation as part of a multidisciplinary and multi-institutional consortium (described in Ganter & Haver, 2020), we collaborated with faculty from nursing and social work to expand the audience of the course to include health professions students and social work students (see, e.g., Bishop, Piercey, & Stone, 2020). To support habits of mind, the course was already built on inquiry-based learning (see Hassi & Laursen, 2015). Through collaboration we encountered more extensive scenario-based forms of teaching, including case studies and simulated role-playing games. In addition to the games, throughout the course students are asked to complete tasks such as recommending action in professional roles.

## **The Game**

We use week-long role-playing games to “bookend” the course. These games were modeled on RTTP – students were assigned character roles with victory conditions and worked in factions. The first game, which introduces the course, is based on a budget crisis at a rural health clinic. This game requires no specific mathematical prerequisites other than reading a spreadsheet and could be used in courses outside of mathematics. The clinic in the game was modeled after a real clinic in a nearby community. One of our grant collaborators connected us to the Executive Director of the clinic, where we were given some historical background, a sample budget, and a tour of the facilities (which included a separate shelter for abused women). During the game, students work in teams to develop arguments and deliver speeches to try to convince others to adopt their points of view in order to satisfy their victory conditions. In most disputes, there is one faction or set of characters who can be swayed toward one of the two opposing positions.

The course concludes with a second role-playing game, centered on funding for remediation in the Flint Water Crisis and involves using the modeling techniques introduced in the class. The Flint Water Crisis game proved problematic (see Piercey, 2022). We are currently considering a replacement (possibly developing a game around Chernobyl). In this paper, we will focus on the rural health clinic game.

### ***Learning Goals***

As an introduction to the course, the goal of the rural health clinic game is for students to incorporate data into their argumentation. This includes not just adding data into an argument, but also anticipating opponents’ arguments and preparing counterarguments. Doing so requires sifting through multiple layers of data to make one’s argument as precise and strong as possible. Implicit in this task is creating an organized mental schema of how all the data fit together.

Each student is given a role, which includes background information, secrets that their character knows, and their character’s goals and desires. Each character is part of a faction – administration, health care providers, and social work providers. Each faction has victory conditions, and each individual role has their own victory conditions. In a couple of cases, a character may have an individual victory condition that is opposed to their faction’s victory condition.

Through the role-playing, students see how easy it is to use data to make arguments that are driven by an individual agenda as opposed to a search for the best solution to a problem. This both provides exposure to how data-based arguments sound objective but are often not as well as raises ethical questions surrounding cherry-picking evidence.

Note that while the game uses mechanics modeled after *Reacting to the Past*, this is not a *Reacting to the Past* game. The goals are very different. The goals of a *Reacting to the Past* game involve the clash of big ideas. This is not present in this game, as the focus is on the use of data. In addition, the scenario is fictional as opposed to historical.

### ***The Scenario***

The entire game is rooted in “solving a problem” as one might in a math class – balance the budget of a health clinic set in a rural environment.

The scenario involves responding to Medicare and Medicaid cuts that impact the funding for the clinic. The clinic serves low-income residents of the Baldwin, Michigan area. This is a rural area that is not far from campus. While most people think of rural communities as predominantly white, Baldwin has a relatively high black population due to historical connections with the nearby Idlewild resort for black artists. As such, the game involves the ability to provide services not only to those marginalized through poverty, but also through race.

The budget is provided to students in a spreadsheet. The total budget for the clinic is about \$100,000. The Medicaid and Medicare cuts reduce revenue by about \$20,000 resulting in a relatively significant budget deficit. The expenses are divided into three categories – Administrative, Health Care Provision, and Social Work Provision. The categories correspond to the factions, and each faction must protect their portion of the budget.

Additional budget information is provided to the students. Each of the three categories has 4 different line items. Additional sheets in the Excel workbook provide more details about the assumptions and calculations that went into the budget for each line item. There are also additional documents that provide even further data, assumptions, and justifications for each line item in each category. Typically, I distribute those documents after the first day of gameplay once the students familiarize themselves with the data in the spreadsheet. One of the student tasks is to create a mental schema organizing all these data.

There are several points of contention among the various roles and characters that are built into the game and provide opportunities to solve the problem. Some have little to nothing to do with the data, but the students must couch all their arguments and disguise their agendas with data.

These issues, among others, include the potential sale of a shelter for abused women owned by the clinic, identifying an error in the state Medicaid allotment, deciding whether to eliminate paid employees and paid social workers on contract (or reduce their hours), deciding whether to continue to fund rewards for volunteers, and deciding whether to continue support for short-distance travel and government filing fees for social work clients. The administration wants to sell the shelter and purchase a new home to serve in its place (which would not only cover the budget deficit but leave funds leftover for some needed equipment replacement), but the only available new home for the shelter is both very easy to find and in a neighborhood with two bars and a strip club. The error in the state Medicaid allotment was discovered by one of the nurses, Cassandra, who is known to be a conspiracy theorist and generally not trusted. Paid employees and social workers on contract do not want to lose their jobs nor reduce their hours, but there are current volunteers who would like to see this happen for personal reasons. For example, one volunteer thinks a paid nurse had an affair with their spouse. The reward funding for volunteers is small, and only one character and only one faction care about this line item, but it is a possible cut for those looking “between the couch cushions.” Finally, the support to help social work clients travel short distances and to pay government filing fees (for driver’s licenses for example) is very important to the social workers.

### ***Factions and Roles***

As described above, there are three factions: administration, health care providers, and social work providers. These factions correspond to the student audiences for the course – business students, health professions students, and social work students.

There are faction-level and role-level victory conditions. There is also a cooperative victory condition: a balanced budget must be adopted by majority vote. Everybody loses if that condition is not met. Put in mathematics terms – the problem must be solved.

Each faction has a victory condition that their portion of the budget cannot be reduced by more than 5%. This gives them a little room for compromise. In addition, the justification of votes, decisions, and argument by data is another victory condition across all three factions.

Each faction has their own specific victory conditions (Table 1):

**Table 1**  
Faction Victory Conditions

<b>Faction</b>	<b>Victory Conditions</b>
Administration	<ol style="list-style-type: none"> <li>1. Move the shelter for abused women to the alternative house.</li> <li>2. Replace at least one paid nurse with a volunteer.</li> <li>3. Replace at least one social work contract with a volunteer.</li> </ol>
Health Care Providers	<ol style="list-style-type: none"> <li>1. Maintain sufficient medications and supplies.</li> <li>2. Continue to reward volunteer health providers at current levels.</li> </ol>
Social Work Providers	<ol style="list-style-type: none"> <li>1. Keep the shelter at its current location.</li> <li>2. Keep all paid contractors/paid social work employees at current levels.</li> <li>3. Maintain travel and filing fee support at current levels.</li> </ol>

Individual roles within each faction have their own victory conditions, mostly related to the issues described in Table 1. Almost all the characters have an individual victory condition related to keeping Cassandra from raising any issues for discussion, but there are two characters who are supportive of Cassandra. Some character’s victory conditions are more specific than their faction’s victory conditions, and a couple are secretly in opposition. For controversies that aren’t addressed in faction victory conditions, different “sides” are scattered across the factions. Finally, there is a character whose top concern is the treatment of racial minorities in the community, and that character has a victory condition that the community demographics are discussed during the game.

***Classroom Facilitation***

The first day is dedicated to introducing the game. I do this on the very first day of class. The syllabus is available online, and we wait to talk about it until after the game (students are encouraged to read it on their own). The statement I want to make by doing so is that this course is going to be different.

I introduce the game by describing the scenario, sharing pictures of the actual clinic that the game is roughly based on, and going over the data in the spreadsheet. Students are given a little time to explore the spreadsheet and given a few things to change in the details of the line items. The Excel workbook has links in the cells so that students only need to change the raw data and Excel takes care of all the implications. Students are also given their role sheets on the first day and given a journal assignment to get to know and write about their character.

After the introduction, gameplay takes about 3 to 4 class days. This class meets 4 days per week, so gameplay can be finished by the end of the week or extended by one day. This is usually a decision I

make in the moment, trying to balance when discussions are “peaking” or whether an additional day would result in repetition of the same arguments. It is important to have a deadline for the game to have some pressure for the students to “solve the problem” so that they don’t all lose.

During gameplay, factions meet and discuss their arguments and strategies. Once they think they have a winning argument, they take the floor and “make a motion” to adopt a proposed revised budget. They share their changes and justify them with the data (and only with the data). There is debate, and a vote. During debate, there are often brief pauses for factions to discuss some point of the argument or proposal themselves. Counteroffers are also made during the debate, and proposals can be altered. If a proposal passes, that completes the game. If the motion is defeated, gameplay continues. To motivate students to take the floor, I remind them that whoever makes a motion is controlling the agenda of discussion.

While factions are meeting, I circulate and listen to the faction discussions. Early in the discussions I troubleshoot, as students are familiarizing themselves with the data, the spreadsheet, the scenario, their factions, and their characters. Sometimes I have private conversations with students if some secret point about their character needs clarification. In later stages of gameplay, I help students strategize and construct arguments. I often ask them to identify the data that supports their argument, ask them to consider the arguments of other factions and prepare counterarguments, and point out where there might be opportunities for them to make deals with other characters or factions.

Each day is concluded with a debrief, which takes students out of their characters before leaving the class. This is critical to diffuse tension in the class by having students consider the state of play from their own point of view, instead of their characters’. This creates space for students to express appreciation for their classmates’ opposing arguments.

Following the conclusion of the game, we reflect on the experience by discussing reflection prompts. We discuss the role data played in the argument, how data can make an argument or agenda rooted in personal preferences seem objective, and whether it is ethical to form your argument before examining data.

### ***Student Reflection***

During the game, students write daily journal entries about topics related to the game and the data. The purpose is to get them to reflect on the relationship between the data and their arguments, or between the data and the agendas of both their characters and other characters.

At the conclusion of the game, students write a reflection that summarizes what they learned from the experience, including a summary of the arguments made and the data that justified those arguments.

Student written work is graded on completion.

### **Concluding Observations: Assessment Challenges and Student Reactions**

We have not had an opportunity to perform a more formal assessment of the impact. So far, I have been the only instructor who uses the role-playing games in the course. There are three other professors who teach the course, and they do not feel confident using the games yet. While this provides and

environment in which we can make comparative assessments, these plans got sidelined due to the COVID pandemic.

Anecdotally, student reaction has been quite strong. They engage intensely with the game, forming Google groups for asynchronous discussion that evolve into communities during the rest of the course. They do their own background research, sometimes seeking to find alternative solutions that aren't obvious. For example, one pair of students decided that they wanted to sell the car that the clinic owns and uses to provide transportation for social work clients. They made some assumptions and found a selling price on Kelly Blue Book (but it was small). They conduct research on appropriate conditions for shelters for abused women, or they look up the features and costs of replacement equipment.

Beyond engagement, during this game students examine one another's assumptions and how they may be related to their professions. The strongest illustration concerns the shelter. The business students in the administration faction seemed to see the argument in terms of dollars and cents, while the social work students saw the problem through the eyes of a victim of domestic violence. During debriefs, I often had students summarize the opposing arguments so that they could appreciate different sensibilities. To this end, during the second game at the end of the course, I like to "counter-cast" – for example, having Social Work students play characters that are focused nearly exclusively on bottom lines.

For more on the student perspective in this game, we invite you to watch interviews with the authors and students at <http://bit.ly/RuralHealthClinic>.

Students are used to "solving problems" in a mathematics class. However, students rarely have opportunities to grapple with complex problems with multiple layers in which potential solutions are linked with individual agendas. Role-playing scenarios with data provide students with such experiences and as such, supports the kinds of habits of mind we want to teach in quantitative reasoning.

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### **References**

Albright, C.L. (2017). Harnessing students' competitive spirit: Using reacting to the past to structure introductory Greek culture class. *The Classical Journal*, 112(3). (pp. 364-379).

Bishop, R., V. Piercey, & M. Stone (2020). Using a faculty learning community to promote interdisciplinary course reform. *Journal of Mathematics and Science: Collaborative Explorations*, 16(1) (pp. 69–83).

Boersma, S. & Klyve, D. (2013). Measuring habits of mind: Toward a prompt-less instrument for assessing quantitative literacy. *Numeracy*, 6(1), Article 6. <http://dx.doi.org/10.5038/1936-4660.6.1.6>

Carnes, M.C. (2018). *Minds on fire: How role-immersion games transform college*. Harvard University Press.



Costa, A. & B. Kallick (Eds.) (2000). *Integrating and sustaining habits of mind*. Association for Supervision and Curriculum Development.

Curran, J., Higbee, M., Jones, R.D., & Ross, A. (2012). *Ways and means, 1935: Debating the social security act through math* [Game]. Reacting to the Past Consortium.

Egenfeldt-Nielsen, S., B. Meyer, & B.H. Sørensen (Eds.) (2011). *Serious games in education: A global perspective*. Aarhus University Press.

Fisher, F. (2019). What do we mean by quantitative literacy? In L. Tunstall, G. Karaali, and V. Piercey (Eds.). *Shifting contests, stable core: Advancing quantitative literacy in higher education* (pp. 3–14). Mathematical Association of America Press.

Fisher, F., Warner, J., & Mickelson, N. (2019). Cardboard cities, real mathematics: Employing quantitative literacy to study gentrification in NYC. *Problems, Resources, and Issues in Mathematics Undergraduate Studies*, 29(9), 908–927.

Ganter, S.L. & Barker, W. (2004). *The Curriculum foundations project: Voices of the partner disciplines*. Mathematical Association of America.

<https://www.maa.org/sites/default/files/pdf/CUPM/crafty/curriculum-foundations.pdf>

Ganter, S.L. & Haver, W. (2020). The need for interdisciplinary conversations. *The Journal of Mathematics and Science: Collaborative Explorations*, 16(1). Article 2. <https://doi.org/10.25891/wbqk-0p09>

Gasper-Hulvat, M. (2018). Gaming the guerilla girls. *Journal for Research and Practice in College Teaching*, 3(2) (pp. 29–33).

Gaze, E. (2014). Teaching quantitative reasoning: A better context for algebra. *Numeracy*, 7(1), Article 1. <http://dx.doi.org/10.5038/1936-4660.7.1.1>

Gaze, E. (2019). Thinking quantitatively: Creating and teaching a quantitative reasoning course. In L. Tunstall, G. Karaali, and V. Piercey (Eds.). *Shifting contests, stable core: Advancing quantitative literacy in higher education* (pp. 49 – 65). Mathematical Association of America Press.

Hassi, M.L. & Laursen, S.L. (2015). Transformative learning: Personal empowerment in learning mathematics. *Journal of Transformative Education*, 13(4) (pp. 316–340).

Joyce, K.E., A. Lamey, & N. Martin (2018). Teaching philosophy through a role-immersion game: Reacting to the past. *Teaching Philosophy*, 41(2) (pp. 175–198).

Karaali, G., Villafane-Hernandez, E.H., & Taylor, J.A. (2016). What's in a name? A critical review of definitions of quantitative literacy, numeracy, and quantitative reasoning. *Numeracy*, 9(1), Article 2. <http://dx.doi.org/10.5038/1936-4660.9.1.2>

Madison, B.L., Boersma, S., Diefenderfer, C.L., & Dingman, S.W. (2012). *Case studies for quantitative reasoning: A casebook of media articles* (3<sup>rd</sup> ed). Pearson Learning Solutions.

Madison, B.L. (2019). Quantitative literacy: An orphan no more. In L. Tunstall, G. Karaali, and V. Piercey (Eds.). *Shifting contests, stable core: Advancing quantitative literacy in higher education* (pp. 37–46). Mathematical Association of America Press.

Paulos, J.A. (2013). *A mathematician reads the newspaper*. Basic Books.

Piercey, V. & E. Militzer (2017). An inquiry-based quantitative reasoning course for business students. *Problems, Resources, and Issues in Mathematics Undergraduate Studies*, 27(7) (pp. 693–706).

Piercey, V. (2017). A quantitative reasoning approach to algebra using inquiry-based learning. *Numeracy*, 10(2). Article 4.

Piercey, V. (2019). Quantitative ethics. In Karaali, G. & L. Khadjavi (Eds.) (2019). *Mathematics for social justice: Resources for the college classroom*. Mathematical Association of America (pp. 53–60).

Piercey, V. (2022). A failed context: Reflections on a mathematics role-playing game about the Flint water crisis, this volume.

Steen, L.A. (Ed.). (2001). *Mathematics and democracy: The case for quantitative literacy*. Woodrow Wilson National Foundation.

Stroessner, S.J., L.S. Beckerman, & A. Whitaker (2009). All the world's a stage? Consequences of a role-playing pedagogy on psychological factors and writing and rhetorical skill in college undergraduates. *Journal of Educational Psychology*, 101(3) (pp. 605-620).