

Learning Team Theories and Measurement through the Game Pandemic

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Teamwork is paramount in many modern day career fields. It is important for HF students and professionals to understand the knowledge, skills, and attitudes requisite for excellent teamwork and to grasp the many hurdles that exist in appropriately measuring its major constructs. Although theories can be imparted didactically, and ideas for measurement discussed, conducting team based research continues to be extremely difficult in particular for measuring team behaviors. This article discusses a potential remedy to this issue through the team-based game “Pandemic[®]”. This game has players work together on teams of 2-4 individuals whose goal is to cure the world from a set of 4 diseases that are eradicating humanity. It forces individuals to be resourceful and work together - and exemplifies many of the behavioral, attitudinal and cognitive components of teamwork. This article will discuss a) the major theories of teamwork that should be taught alongside this game as an in-class activity, b) the KSAs, team processes, and measurable outcomes that Pandemic entails, and c) an example of ways to integrate the game into semester long activities to give students insight into teamwork and teamwork measurement.

INTRODUCTION

Teamwork is recognized as a key skill for professionals across a variety of disciplines. Working in teams is often cited by employers as the primary function for performance, having skills in teamwork is touted as necessary for employee on-boarding (Hughes & Jones, 2011). Educators in psychology who focus on teamwork as a research domain struggle with both teaching the concepts of teamwork to future team researchers and educating undergraduate students across disciplines to prepare them to be effective team members for the workforce. A tool that will aid students in both understanding teamwork as a team member and as a scientist interested in team measurement would benefit the pedagogy of teamwork.

Part of the challenge could be attributed to the definition of effective teamwork being viewed as highly context specific and the lack of an activity that can be used in the classroom to provide experiential learning beyond that of class team assignments. Educators often rely on such commonly used activities as movie clips or publicly available videos of teams. Activities that allow students to experience engaged teamwork with an opportunity to observe teamwork processes are limited (Riebe, Roepen, Santarelli, & Marchioro, 2010). We will describe a promising approach to conducting research in the area of teamwork as well as a pedagogical approach which can be used in the classroom. Pandemic has been used in lab based research for assessing the impact of leadership on teamwork processes (DiazGranados, 2011), and also in the classroom to teach students about teamwork processes via behavioral observations of teamwork processes, specifically communication. Below we will discuss the board game used for this activity, how it was integrated into class time, potential educational assignments, and theoretical and measurement considerations for learning opportunities.

THEORETICAL FOUNDATION

Teamwork is a dynamic and episodic process that involves cognitions, attitudes, and behaviors among team members while they work to accomplish a common goal (Salas, Shuffler, Thayer, Bedwell, & Lazzara, in press). The literature on teamwork is abundant and thus, it is difficult to extrapolate a set of common principles that can aid in the understanding of factors that influence effective teamwork. In a recent article, Salas and colleagues (in press) reviewed the literature to present an overarching heuristic of the most critical factors of teamwork. This heuristic is relevant to the approach discussed in this article for two reasons. First, the heuristic is based on several decades of teamwork literature, thus being grounded in

team theory. Second, the heuristic is focused on practice. Given this focus, the heuristic can provide potential answers to the challenges related to training concepts and measurement of teamwork, for both future team scholars and the future workforce.

The heuristic developed by Salas and colleagues (in press) was designed to highlight six core processes and emergent states that represent the cognitions, attitudes and behaviors central to effective teamwork. Specifically, the authors discuss the need for cooperation, coordination, and communication across team members. Moreover, the development of shared knowledge (or cognition) of those involved in accomplishing a task, it may be individually held or shared across members. In addition, the engagement of coaching activities, which include activities from those internal and external to the team, that assist teams during times of process loss and when barriers arise. Finally, managing conflict is also critical. Conflict can be disguised in many ways but a team who can operate and function beyond conflict will develop better management strategies, which will alleviate the negative impacts of conflict.

These core processes and emergent states are influenced by certain conditions. The influencing conditions—team composition, context, and culture—are the factors that may shape the method in which team members engage in teamwork processes and develop team emergent states. Team composition influences team performance by the variety in team member knowledge, skills, abilities, personalities, etc. (Cannon-Bowers & Bowers, 2010). Context influences teamwork by defining factors such as autonomy, accountability, and the resources available to the team (Johns, 2006). Finally, culture influences teamwork because of differing assumptions held by team members regarding the values, beliefs, and norms for social behavior. This heuristic provides a foundation for assessing an experiential task, like Pandemic, as a teaching and research tool.

PANDEMIC

As stated above, teaching teamwork measurement in the classroom is a difficult challenge. Specifically, activities that allow students to have an in depth look at an actual team are limited, and often educators must rely on resources such as videos of teams, movie footage, etc. Below we discuss a potential solution for teaching these concepts in a classroom or workshop setting through a team board game. This can aid individuals in understanding teamwork both as a team member and someone conducting team measurement. This paper was inspired by a dissertation that used this board game to understand power distance and leadership in a simulated team task (DiazGranados, 2011), and was developed for a

classroom activity that is part of a graduate Seminar in Human Factors on Teams and Training. Below we will discuss the board game used for this activity, how it was integrated into class time, best practices for discussion of relevant theories related to the game, and potential educational assignments with an example of one student's communication measurement tool designed throughout the course.

THE RULES

Pandemic® (Leacock, 2012) is a multiplayer team board game (Figure 1) for up to 4 players. Players are tasked with the shared goal of curing a set of 4 diseases (blue, red, yellow, and black) that are going to eradicate humanity. Each disease is centered in a geographic location (blue = North America and Western Europe; red = Asia, Indochina, and Australia; yellow = South America and Africa; and black = Eastern Europe and the Middle East). Players choose a role randomly (described below), and each role comes with its own set of abilities and special movements that aid the team in reaching the overarching goal of curing all 4 diseases. Further, players have a deck of cards (the player deck) that gives them cards of different cities during each turn. These can be used for movement or curing diseases, which will be explained in detail below. These cards are color coded to align with the 4 diseases (blue, red, yellow, and black). The diseases are represented by cubes that are placed on a world map containing major cities. The game simulates the spread of the disease through a deck of 48 cards (the infection deck) with city names – each turn players must turn over the top cards of this deck and “infect” the given cities with cubes. Cities that have more than 3 cubes “outbreak” and players must place a cube on each adjacent city. This can lead to a chain reaction if those cities also have 3 cubes.

During each player's turn, they can move to cities, cure disease cubes, trade cards with other players from the player deck, or perform one of the special actions dictated by their specific role. This continues until either the players win by eradicating all 4 diseases, or lose when there are 8 total outbreaks, they run out of the cards in their deck (59 total), or no cubes are left in a specific color of disease. To make matters worse for the players, the player deck also contains epidemic cards. If one of these cards is drawn, then the cards in the infection deck discard pile are shuffled and placed on top of the deck – drastically increasing the chances of an outbreak in cities recently infected. Players find some alleviation from special “event” cards that give them certain temporary abilities when played.



Roles

The newest version of Pandemic® contains 7 possible roles, which are randomly selected at the beginning of each game. Given that a maximum of 4 roles can be used during any given game, this can lead to a large dynamic in the structure of the team's

composition. What differentiates roles from one another is a set of special or unique abilities that only that role can perform. These can be related to many factors of gameplay including movement, exchanging cards, or creating cures, to name a few. Below we will discuss each role in relation to its special skills:

Contingency planner. The Contingency Planner gives players a second chance to use previously used event cards. The *contingency planner* can take already used event cards from the discard pile and save them for a time where they need to play them again. After the event card has been played a second time, it is removed from the game.

Dispatcher. The Dispatcher may move other player's pawns to any city with another pawn present. They may also move other players on the dispatcher's turn as if it were his/her own turn.

Medic. The Medic has a unique ability to treat infections. Medics remove all cubes on an infected city for 1 action point. If a disease has been cured, a medic needs to merely travel to a city and cubes are automatically removed. Also, while a medic is present on a city no more cubes can be added to that city.

Operations expert. The Operations Expert can build research stations without the need of the city card. They simply spend 1 action point and place a research station in the city where their pawn is located. They can also move their pawn from its current city to any research station in the world by discarding any city card.

Quarantine Specialist. The Quarantine Specialist prevents the spread of disease in cities adjacent to its pawn. Specifically, any city where the Quarantine Specialist is located cannot have outbreaks or disease cubes placed on it during normal infections.

Researcher. The Researcher can exchange city cards more easily than normal players. The Researcher can give any city card to any player in the same city. The card does not need to match the city both pawns are in as it does with normal players.

Scientist. The Scientist can cure diseases more easily than normal players. The Scientist only needs to discard 4 cards to cure a disease.

TEAMWORK IN PANDEMIC

Pandemic provides a complex gaming environment that taps into a multitude of teamwork constructs. Teams must do all of the following to be successful:

- Consider which roles they choose and which roles other team members choose (composition)
- Clearly understand their own role and others roles (cognition)
- Articulate their goals and how their current actions are reaching those goals (communication)
- Express what they are doing during their turn in relation to the goal structure of the team (cooperation),
- Ensure that certain actions are done in the right order, during the right turn (coordination),
- Observe what other team members are doing and ensure it's the best course of action (coaching),
- Commit to actions they do not want to perform or argue over the proper course of action to get the best results (conflict).

Below we will discuss each of these in more detail in relation to introducing this game as a way to teach teamwork.

Major KSAs of teamwork

Below we will briefly discuss each of the major constructs of teamwork that are elicited by the game Pandemic and conceptualized by Salas, et al. (in press). We believe that it is important to highlight each of these to the class before introducing Pandemic into classroom activities. This gives students a theoretical background to think about while they participate in the game.

Composition – The respective roles and expertise of the team membership.

Cognition – Shared mental models and team understanding of each other’s knowledge.

Communication – The pushing and receiving of information between members of the team.

Cooperation – Intrinsic and extrinsic motivation that pushes the team to perform well together.

Coordination – Actions in concert needed to complete a set of shared goals.

Coaching – The manifestation of leadership in relation to resource management and goal setting.

Conflict – The lack of overlap between different team member’s perspectives, experience, and evaluation of decisions in relation to team goals.

IMPLEMENTING PANDEMIC® IN THE CLASSROOM

This game presents a challenging environment that demands excellent teamwork for the players to succeed. Therefore, it was adapted into a semester-long classroom activity to exemplify how teams work together and also to provide a real team in action so that non-playing students can observe and measure teamwork in real time. To best implement this game in a learning context, we advise that instructors couple the lessons on teamwork with the game such that students can learn about an aspect of teamwork, and then attempt to apply it in the game during their next play session.

Composition

Given the various roles included in Pandemic, composition can be a focus of discussion once students have learned the rules and the need for various roles. One demonstration to show how important composition is to team functioning could be to assign some of the weaker roles (e.g. operations expert) to a team member who usually plays with a more important or crucial role (e.g. dispatcher) and see how it affects the team’s ability to perform. Another demo could have two teams play the game simultaneously, with one team being allowed to choose whatever roles they want, and the other forced to play with the roles that they either don’t like or don’t believe to be effective. Following this game, the class can discuss the differences that composition may have had on their in game performance.

Another team composition oriented activity was implemented during the last day of class: Team members were randomly switched to other teams. Much like in the real world where team membership is dynamic and often fluid, we believe this activity could really exemplify realistic situations. To supplement this activity, teams were surveyed post-performance on the differences between their usual teams and these new teams. They were asked to specifically address differences in the major KSAs of teamwork between their usual teams and the newly formed teams.

Cognition

A discussion of the requisite knowledge needed to perform well during Pandemic play helps the class understand the idea of cognition and expertise. As students get better at the game, it is vital to reintroduce this idea and discuss with them how they have changed individually in their approach to playing, what knowledge about the games rules and mechanics helps them play well, and what things they would teach to a novice just learning the game.

Communication

The implementation of closed loop communication is an effective teamwork strategy. The students were taught about the need for closing the loop during communication events, through acknowledging receipt of a question or statement, and also through

asking clarifying questions. The team members apply this strategy throughout their gameplay. Although some of them mock the idea in the beginning, as they gain experience playing they tend to become more adept at closing the loop of communication.

Another aspect of communication that can be taught in the classroom is the need for everyone on the team to speak up. Early on in the semester leaders will emerge on the teams, and some may dominate the game. This leaves some of the more introverted or shy students to become detached and say little throughout game play.

Cooperation

One of the unique aspects of Pandemic is the fact that it is a team game with true interdependency. Given this, students tend to first play in with competition in mind, and do not immediately understand that working together is the only way to win. As each group struggles with leadership and strategy, cooperation becomes extremely important. This was highlighted in the class by observation of teams that cooperate well and those that do not. Instructors can demonstrate this by asking some students on a team to be extremely disagreeable with all decisions. Clear observable effects include lag in game play, inability to make clear strategies and decisions, and problems combatting the spreading diseases in game. Following the instructor can then ask the team to be cooperative and agreeable. Over time, the author’s noticed that this naturally occurs as students learn the game and become less competitive within their team.

Another instructor strategy to increase cooperation is to have a running leader board for the entire class, giving individual’s incentive to work well together as they compete against other teams in the classroom. Discussing behaviors from the first few days of playing in contrast to each teams final performance will help students understand how they changed in regards to cooperation.

Coordination

Coordination can be taught through a class lesson on the strategies the teams have devised playing the game. After students have played the game a couple times, a lesson can be created that focuses on what the major goals of the team are, how those goals are obtained, and the types of strategies that work. This lesson can highlight the differences between the roles, and which roles are the “best” and the “worst” depending on the way the different teams play and their membership.

Coaching

In the beginning of the semester, students can be assigned a role that they play in every game. A good way to instill coaching is to have students exchange their roles once they become familiar with them. This gives the individuals who were playing that role formally a chance to coach the new player in that role. After action review can be used to discuss how this changed game play, the way the team communicated, and the performance outcomes of the team.

Conflict

We suggest that a lesson on the importance of conflict resolution can aid students in understanding how conflict is an integral part of teamwork, but the way conflicts are resolved is more important. There will be many disagreements throughout a game as the students learn how to play. Due to the multitude of possible plays students may not always agree with the course of action decided by the team. Along with communication, speaking up in the face of group agreement can show the students the important of devil’s advocacy, and giving students lessons on resolution techniques can show them real world skills for dealing with conflicts effectively.

DEVELOPING METRICS THROUGH OBSERVING PANDEMIC TEAMS

Behavioral Metrics

A semester-long activity for using Pandemic in the classroom consisted of designing a measurement tool that assesses any teamwork construct of interest to the student. This assignment has a three-fold purpose: 1) Provide students a chance to develop a metric that can be used to measure teamwork based in theories learned in the classroom; 2) Give students an opportunity to use the metric and then create iterative designs based on lessons learned while using it; and 3) Allow students to understand the difficulty of measuring teamwork while observing live teams.

A majority of students at first attempted to measure behaviors. Metrics for behaviors included frequency and quality of communication, number of statements made towards goals, exhibition of leadership behaviors, statements related to collective efficacy, etc. Given this – many students quickly identified that it is extremely difficult to measure these constructs while observing the game in progress.

Demonstrating the difficulty of behavioral measurement

One of the first things that can be shown to students concerning team measurement is the difficulty of measuring behaviors. The first assignment was for students to make a metric measuring any team behavior of interest. They were given a week to prepare their metric, and then were given an entire hour-long class period to observe some of their other classmates playing Pandemic. By the end of this first session many students realized their measures were entirely impractical. Some realized that using video footage would be the only way to properly assess what they were attempting to measure. Others realized they would need a set of raters to assess inter-rater reliability. Although limited to observing Pandemic team performance, one student developed a software platform for behavioral observation. We will discuss this particular measure in more detail below.

Example of a Student's Communication Frequency Metric

One student decided to develop a computer-based observational tool for measurement of communication in real time. This tool was created using Matlab software. Below we will discuss how the tool works and what aspects of teamwork it measures.

This measure consists of a user interface programmed in Matlab. To start, the user enters the size of the team and the team member names into the program. When the program begins, the team members are arranged on the user screen as rectangular buttons with respect to how they are arranged in the room being observed. A team button is placed in the center of the team member button arrangement (Figure 2). This button represents communications that are directed at the entire team.

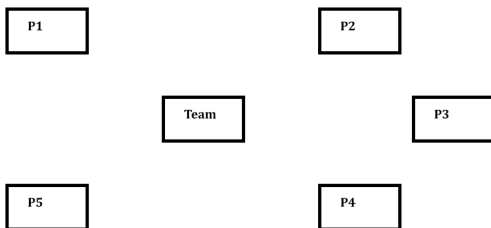


Figure 2. The student's team communication measure GUI.

At this point, the user/observer is ready to record team communications. To record a team communication, the user will right

click the team member that is speaking and left click the team member that is receiving the message. If it seems the sender is attempting to communicate with the group as a whole, the team button is left clicked. In addition, each registered communication is time stamped. As described by the student who developed this application, "This simple program provides team observers with a fast and efficient way to temporally measure the frequency of team communication."

Table 1 displays an example output of the program. The rows represent who was sending the message and the columns represent who was receiving that message. In this table we see that participant two communicated notably more than the other participants. Using this data, one might postulate the emergence of participant two as a team leader. This same data can be represented as a communication web, where line thickness is weighted with respect to the frequency of communications between those two participants (Figure 3). It should be mentioned that these results are communication totals. The data is also capable of being organized temporally. Therefore, a researcher could compare the communications surrounding key team events to others.

Table 1. Communication frequency counts.

		Receiver						Total
		P1	P2	P3	P4	P5	Team	
Send er	P1		41	15	7	15	55	133
	P2	39		23	29	23	86	200
	P3	5	14		1	0	26	46
	P4	14	26	8		12	21	81
	P5	9	11	1	3		19	43

While this student's program is interesting, it is important to present the limitations. As it stands, the program does not record any information about each specific communication other than temporal. Potential next steps for this program are to add categorical tags to each frequency count, so that communication can be more easily interpreted. For example, the data presented in table 1 present's participant two as the team member who communicates the most. However, if we add categorical tags to each communication, we might find that this participant was often repeating himself or herself. In this circumstance, we might rethink his or her emergence as a team leader.

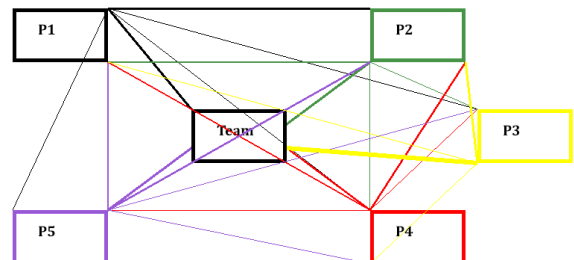


Figure 3. Sample communication web.

CONCLUSIONS

This paper highlights a potential resource for teachers or workshop designers to implement a fun and interactive way to teach teamwork and team assessment. Although we have not covered all potential avenues for using this method, we believe this paper establishes a basis for integration in a variety of settings. We hope that this enables others to teach the science of teamwork in their own classrooms and develop new techniques for integration of Pandemic. Pandemic or similar gaming environments can provide a robust and applied learning experience to students at many educational levels.

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