

# Unexpected game calculations in educational wargaming: Design flaw or beneficial to learning?

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## **ABSTRACT**

This paper describes situations where learning games are not perceived by the player as being realistic. In educational wargaming this is seen when the game calculates battle-outcomes. Defined as unexpected game calculations, these incidents can cause players to adopt a Gamer Mode attitude, in which players reject the idea that the game accurately portrays warfare. In a study involving cadets playing a commercial strategic wargame as part of their course in war science, unexpected game calculations emerged and resulted in different user responses. Although user responses risked damaging the worth of learning from gaming, this paper argues that these incidents could enhance learning, as the cadets became interested and keen on finding rationales to why and how unexpected calculations occur.

## **Keywords**

Game-based learning, military education, simulations, user responses, wargaming,

## **INTRODUCTION**

Professional uses of simulators and games have successfully been employed in military education for centuries (Smith, 2010). In wargaming, the focus is on examining conflict in an artificial environment (Rubel, 2006) and on the exercise of human decision making (Perla, 1990). However, wargaming and other educational uses of games are not without difficulties, as players may use the game differently from what is intended (Rieber & Noah, 2008). One such irregularity occurs when players try to achieve the game goals in ways that divert them from the learning objectives. Their attitude becomes one of Gamer Mode, which is defined as “gaming the game” instead of nurturing learning goals (Frank, in press). One root of this problem is the game itself, specifically the goals designed in the game (Lind, 1985) that tempt players to become over-aggressive. The consequences, beyond the observable deficient attitude toward the game, are un-tactical behavior and higher risk tendencies among the players.

One reason for players to change their attitude towards the game is when the game is not perceived as realistic enough; when the game does not live up to the players’ expectations. Educational wargaming requires that players have an essential familiarity with warfare; otherwise players would find it hard to play the role of commander and approach the wargame professionally. Consequently, the wargame must live up to the

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players' knowledge of warfare or else playing the game will create a fictional environment with little or no relation to the real world.

One specific and sensitive situation is when the game calculates a battle-outcome. This situation can trigger an attitude change as the players reject the outcome calculated by the game's inner logic. This may allow for a player attitude like Gamer Mode (Frank, in press) to emerge as players no longer accept the game as correctly illustrating warfare. In Gamer Mode the player treats the wargame *only* as a game and not as a representation of warfare.

To shed some light on this potential discrepancy between the player and the game, we decided to study a wargaming session during which young officers were to learn basic battalion combat. Our interest was in events when the players responded to results from the game calculations, specifically those that came unexpectedly or as a surprise. Furthermore, we wanted to identify the consequences of those events. Finally, we sought to address the questions of whether these events should be avoided at all cost, or if they could be considered valuable for learning.

In this study we found occasions when the cadets were surprised by the game calculations. The results show that user responses varied extensively depending on which side the cadets were playing. This situation risked jeopardizing the whole game session, potentially giving way to negative player attitudes like Gamer Mode. The results also show, however, that these incidents could enhance learning, as the cadets became interested and keen on finding rationales to why and how incidents occurred. This challenged and enriched the students' own belief and knowledge of warfare in important ways.

## **USER RESPONSES TO SIMULATIONS AND GAMES**

Game-based learning is an experience-based learning method in which games stimulate students to perform actions in line with the learning objective. Traditionally, the design of learning games is a question of transforming the learning objectives into game rules and making this mapping as accurate as possible. However, there is a risk of players enacting game rules with a meaning-making process other than that anticipated from a game design perspective (Linderoth, 2004; Rieber & Noah, 2008). This could lead to a player attitude of Gamer Mode, in which players try to achieve the game goals at all cost (Frank, in press). Gamer Mode can be described as a conscious ludic stance in which the player agrees to the goals and rules defined by the game, but not *also* on what the game is meant to represent. In wargaming, this is exemplified by the player moving military units in such ways that the game goals can be achieved without considering the realism and the real-world consequences of these moves. An attitude change can be triggered when the game outcome is different and the game calculations perform differently from what the player expects, not in the sense that the wargame calculates surprising events *per se*, but because it goes beyond what the player can predict as a plausible outcome.

In these situations, the relation between the player's knowledge of warfare and the game's ability to mimic warfare is exposed. Generally, one can argue that unexpected calculations are due to flaws in the game design and should be avoided. However, the specific conditions surrounding wargames make clear why these unexpected calculations occur and why they are probably unavoidable.

First, educational wargaming mandates players to take on potentially conflicting different attitudes simultaneously toward the activity. Because wargaming involves playing a game, the player must take on a lusory attitude (Salen & Zimmerman, 2003; Suits, 2005; 1978) toward the activity. A lusory attitude involves committing to play the game in ways defined by the game rules and can be seen as a social contract that articulates the restrictive use between players and the game. The other attitude involves players having to take on the professional role of an officer. Gredler (2004) distinguishes between educational games and simulations, with the latter involving players taking on a bona fide role with well-defined responsibilities and constraints. With Gredler's terminology wargaming is more associated with educational gaming since it is a competitive exercise and the main objective is to win by overcoming the opponent. However, wargaming also mandates that players take on a professional attitude as they are expected to act and think as officers. This aspect of wargaming is categorized as simulation according to Gredler's definition. Thus players need to have relevant knowledge of warfare; otherwise it would be difficult to command units *as if* it were for real when there is no knowledge of what the units are meant to represent or how to make use of them in war. Wargaming thus seems to contain both simulation and game characteristics (as defined by Gredler) which could generate a tension between playing as a professional and playing to win. Further, while players expect the game to behave correctly based on their knowledge, beliefs, and experiences of warfare they may perceive unexpected game calculations as occurring when the game does not mirror these expectations.

Second, wargames can be used for various learning objectives. One such purpose is to teach specific maneuvers or skills. With this come predefined ways to solve the challenges. Often these kinds of simulators or games are named Part Task Trainers because they are used to train a specific skill-set to learners unfamiliar with the subject matter. Tactical and strategic training is a different beast, which from a design perspective cannot enforce a specific solution. Instead, wargames should be seen as a tool, stimulating players to make interesting choices, and aiding learners to explore the dimensions of decision making in a dynamic environment. Wargames are thus designed in such a way as to give players broad freedom of action, which could generate problems when events in the game are taken in unwanted and unanticipated directions. Furthermore, since a wargame is only a model of warfare, where certain parameters and variables are considered to be more important than others, the game can only be a poor copy of warfare. The central question is whether this "copy" of warfare is consistent with the educational purpose or if the player understands the limits of the game. To avoid confusion between the game and the learning objective, de Freitas and Olivier (2006) introduce a framework to support tutors in evaluating educational games and simulations. They highlight the close dependency between the context, learner, pedagogical considerations, and the tools for use (i.e., the game). With such an approach tutors can choose commercially available games more carefully or highlight important attributes in the game design. Although this may reduce the risk of selecting unsuitable wargames for a specific purpose, there is still a risk that the players may perceive the game to be strange or unrealistic as they may not be fully aware of the limits of the game. Moreover, this risk may be exacerbated by the fact that the relationship between variables in games is not often made explicit.

Third, a common approach to address un-modeled aspects of warfare and uncertainty is to introduce stochastic techniques such as dice rolls. The roll of a die together with structured tables representing probabilistic aspects, tries to accurately depict the battle-outcome. An environment that includes mechanics for randomness creates a dynamic

environment with frictions and surprises associated with warfare. However, randomness risks resulting in outliers, which could trigger a user response in which the players see the game's inner logic as erroneous or flawed.

Assuming unexpected calculations are unavoidable within wargaming, our real concern is what kind of user responses they will trigger. Turkle (1996) speculates on three different user responses to simulations: simulation resignation, in which users take a stance willing to accept the simulation on its own terms; simulation denial, which is a rejection of the simulation ability to mimic real-world phenomenon; and finally, critical challenge, in which users challenge the simulation's built-in assumptions and reinforce their knowledge to "use simulation as a means of consciousness-raising" (Turkle, 1996).

From a learning perspective simulation denial is an unwelcome user response, whereas the other two user responses are more desirable. If unexpected calculations could trigger different user responses, we are interested in whether surprises like these are beneficial or detrimental to learning. Inspired by this idea, we conducted a study among cadets using a commercial wargame to learn basic battalion combat tactics.

## **METHOD**

The study was conducted among military cadets playing an educational wargame over three days, as part of an eight-week course in war science. The wargaming part was one of the final stages in the course, in which they would test their plans and apply the theories they had learned earlier. The cadets used a commercial strategic turned-based game, *The Operational Art of War* (Matrix, 2005), in which we created a specific scenario to match the orders given to the cadets. The game was chosen for this course as it contained all the necessary attributes associated with battalion combat, was fairly easy to use, and enabled training of the whole class simultaneously. We searched for incidents where the calculated battle-outcome resulted in something that the user did not expect—those that were perceived as unlikely to occur. We were interested in whether we could credit the incidents as something valuable or as something harmful that could jeopardize learning. A qualitative analysis was carried out, in order to explore how and why the incidents occurred, in addition to how the cadets made sense of and confronted these incidents,

## **STUDY SET-UP**

### **Participants**

All cadets in the course participated in the study. In total, 81 military cadets participated, consisting of 8 women and 73 men, aged 22 to 36 years. The participants came from different branches within the armed services and were all familiar with the theme of the game.

### **Procedure and setting**

Before the wargaming session, all participants planned the complete scenario using paper maps, thus familiarizing themselves with the terrain and capacities of the military units. Besides learning basic battalion combat, the learning objectives included testing plans in a simulated environment. A custom scenario, Operation Pajazzo, was created specifically for the course using *The Operational Art of War* scenario editor. The scenario was made as a head-to-head battle (at battalion level) with comparable forces on the blue (NATO) and the red (Opfor) side. The NATO mission was to advance north toward the valley below Monte Cassino in Italy and limit the Opfor presence there. At a later stage in the

operation, which was not wargamed, the NATO forces were to advance further up north to Rome. As such, this NATO mission was regarded as an enabler for a later stage. Red side had orders to stop the NATO advance by defending the region around Monte Cassino. The participants played the game in groups of two to three people in duels, NATO side against Opfor side. As they played the game they were instructed to comment on their choices, revealing their reasoning and attitudes. *The Operational Art of War* is a turn-based game, and we allowed each competing side 15 minutes to complete a turn. The battle continued for eight full turns, and in the end, the players discussed the state of the game and the whole game session with an instructor.

Each group played the scenario for three rounds, shifting sides between NATO and Opfor. Before playing Operation Pajazzo, the cadets were given two hours to familiarize themselves with the commercial game.



Figure 1. Screenshot from the game *The Operational Art of War* with the scenario, Operation Pajazzo, used in the course. Set in modern day Italy, the NATO forces in blue are to advance north towards Monte Cassino. The task of Opfor (in red) is to block this advancement.

### Data analysis

The game sessions were recorded using video cameras, audio recorders, and screen captures to enable interaction analysis (Jordan & Henderson, 1995) of the material. As the game was turn-based, we saved all turns for later in-game analysis. This enabled a replay of the moves made in the game and analysis of the end state.

As the amount of data collected was massive, spanning over 440 hours of video tape, sessions was selected by analyzing the end state of each round. Presuming that critical events were likely to occur when military units were destroyed, we searched for end state conditions where at least one military unit was completely destroyed.

Furthermore, as we suspected several mistakes or misconceptions would take place as the cadets were playing Operation Pajazzo for the first time, we excluded the first round from our selection of data. After scanning the end state of the game rounds, we selected five sessions for detailed analysis, spanning data from 11 individuals and a total of 20 hours of video and audio recording.

According to Jordan and Henderson (1995), the goal in interaction analysis is “to identify regularities in the ways in which participants utilize the resources of the complex social and material world of actors and objects within which they operate” (Jordan & Henderson, 1995). In the practice of wargaming, we are thus as interested in how the game is played as we are in how the social interaction takes place outside the screen. For example, the cadets’ reasoning during pauses between their game turns exposes their reasoning around events, gives clues to their sense-making, and reveals underlying assumptions of the game. From a learning perspective, we see this social interaction to be equally important as the game they are playing.

We systematically went through each session searching for game calculations that the players perceived to be unlikely or that came as a surprise. The main problem was to decide upon when these incidents occurred, as many players silently played the game without any explicit response to the events in the game. Therefore, the incidents chosen involved players clearly reasoning around unexpected game calculations. From those incidents, we traced back and analyzed earlier interaction to find clues to why the cadets were startled by such calculations. Where applicable, we also replayed the game turn to identify circumstances that led to the game coming up with such a result. In addition, the interaction after the incident was analyzed to discover specific behavior or attitude changes among the players.



Figure 2: Cadets playing *The Operational Art of War* while a video camera records their interaction.

## RESULTS

Although unexpected game calculations could be found in all analyzed sessions, they varied in many ways. They ranged from small events where players questioned the outcome from the game without any clear observable consequences, to important events where the game calculations changed the way the players behaved. Small events appeared from time to time in all analyzed groups, some more clear than others, depending on how explicit the dialogue was in the group. An example of a small event was when group members discussed specific characteristics of a unit in the game and how this unit was inconsistent with their expertise. Important events were less frequent: not more than three were found among all five analyzed sessions. These events were categorized as important because they generated an intense discussion as well as an observable behavior change among players.

Three situations were chosen to exemplify the findings. The first two concern important events that had negative consequences for the players, either due to flaws in the game or because the players were inattentive. The last situation involved a small event where positive unexpected game calculations emerged among the players. The excerpts below use a format to clarify the interaction taking place: the first column is for identification, the second and third columns expose the utterances, and the fourth column clarifies what happened on the screen and other surrounding factors that were not expressed in words. All names in the excerpts are pseudonyms.

### **Situation 1. An unanticipated event breaks the legitimacy of the game.**

This example illustrates a kind of interaction with the game where the cadets are not willing to accept the game's ability to make valid calculations, ending up in undesired consequences.

The following excerpt (Figure 3) is taken from turn 6, which is close to the end of the round. Larry and Moe are struggling with their Opfor forces; the opponents have rapidly taken vital areas and present a hard challenge. On numerous occasions before turn 6, Larry had expressed despair over the developments. Moe has a more calm position, although he quietly seems to make similar conclusions. During a previous turn they had received reinforcements, an artillery battalion, which Larry positions far from the front. This excerpt starts when Larry opens the game file to see what the opponents (NATO) had done in the previous turn.

1.	Larry	This is outrageous, what kind of game is this!	Larry witnesses how a NATO reconnaissance troop has successfully evaporated their new artillery battalion. He kicks the table where the computer screen is placed.
2.	Cadet sitting nearby	Calm, calm... you have to calm down. (pause) What happened?	Larry faces the cadet with a smile.
3.	Larry	Check this out... Our artillery...our artillery got engaged by a <u>reconnaissance troop!</u>  That's very likely.	Larry makes an ironic gesture along with a laugh.
4.	Another cadet sitting nearby	Artillery battalion?!	
5.	Larry	Yes!	Laughs loudly.
6.	Cadet	They ought to be raised to the nobility.	Refers to the recon troop.
7.	Larry	It is a joke...this is a joke.	Face palms.
8.	Cadet	They are heroes now. They are going to drive in Sveavägen in veteran cars.	The cadet refers to the very heroic and successful act of the reconnaissance troop, which would earn them a triumph parade along a major street in



			Stockholm.
9.	Instructor	One CV90 cleared them apparently.	The instructor walks by and refers to the armed combat vehicle the recon troop has at its disposal.
10.	Larry	(Laughs)	Opens up the current condition screen.
11.	Cadet	"This is a significant defeat"	Reads from the screen.
12.	Larry	Ahhhhhhh...	Face palms.

Figure 3. Excerpt from group when an artillery battalion has been completely evaporated.

As mentioned above, situations are not looking good for the Opfor side. NATO controls vital areas and Opfor has suffered defeats in earlier combat situations. From a tactical point of view, the evaporation of their artillery battalion is not considered critical to the military operation. However, this incident is more than Larry is willing to accept.

Larry's reaction is not unfounded; under normal conditions a reconnaissance troop equipped with only one CV90 (combat vehicle 90) will not have the capacity to evaporate a whole artillery battalion, which is equipped with infantry units to protect the battalion. In analyzing the turn, when we re-played the turn, we got the same outcome over and over. The artillery battalion never avoided a total evaporation, which assumes a flaw in the game scenario. After close inspection of the battalion we saw they were short of protection units. We realized this was an unfortunate event that could have been avoided with a better design of the military units. However, when creating the scenario we did not anticipate that the reconnaissance troop would be used for offensive maneuvers. We also did not anticipate that the artillery battalion would be exposed to direct fire from enemy units, as the artillery firing range covered almost the complete map from where it was deployed. A different argument is that, however true to the real world the model tries to be, these situations are hard to avoid as the cadets creatively use every resource available to their own benefit. The situation exemplifies the difference between an expected use of the game and the actual use by the players.

A change in attitude can be observed from Larry and Moe's reaction. Larry especially has problems maintaining a resignation to the game, which is illustrated in the excerpt below taken 20 minutes later.

13.	Larry	This game is just...something is wrong...these ones we will use, I must say...because they have apparently	Larry describes the overall game and circles the mouse over Opfor reconnaissance
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		some superpowers.	troop.
14.	Moe	Indeed, since they could disable a whole artillery battalion. (pause). It is always these reconnaissance troops that have messed up, haven't they?	Moe faces Larry. Larry finishes the turn.
15.	Larry	This is a fun game isn't it?	Larry does not smile.
16.	Cadet sitting nearby	Take it easy, it is only a game.	

Figure 4. Excerpt from 20 minutes later as they return to discuss the unexpected event.

During this excerpt Larry is quite displeased with the game, as seen in 13. He also returns to the reconnaissance unit and its abilities in the game. Since the opposing side has evaporated their battalion, he renegotiates the function the reconnaissance troop has in the game and tentatively plans to make use of these so-called "superpowers" it seems to be equipped with. Moe agrees to this position 14 by explaining they must possess something extra in the game. In 15, Larry once more exposes his discouragement with the game, but this time with a more serious tone. The cadet sitting nearby tries to ease Larry's stirred-up emotion in 16 by emphasizing how Larry should to view the game session.

Finally, after 10 more minutes, we can observe how the game is being played differently by Larry as he discusses the situation with a cadet standing behind him.

17.	Larry	"This is a draw". Well now we have at least leveled out.	Loads the file and reads from the situation briefing. In an earlier turn the briefing screen had said they would suffer a defeat.  Larry makes various moves to win points on the terrain.
18	Cadet standing in the behind	What turn are you in?	
19.	Moe	Eight	
20.	Cadet	Do you have any chance	

		to win then?	
21.	Moe	Well...	
22.	Cadet	Press the magnifying glass so you can see.	Larry presses the magnifier button to see the current situation and which side is currently winning.
23.	Cadet	But you are winning.	
24.	Larry	Well...it's all because now in the end we are just playing for the points. It's all so ridiculous. I got so upset after that defeat.	Larry refers to the previous unexpected event by pointing out the NATO reconnaissance troop that evaporated the battalion.
25.	Moe	Mmmmm	

Figure 5. The group is explicit on how they play the game.

In their final turn Larry and Moe do what they can to win the remaining points on the map. The game calculates a minor victory for the Opfor which ought to please Larry and Moe. The response from Larry in 24 tells another story. Their defeats throughout the round and the incidents have made Larry and Moe go after points and abandon a professional attitude to the game. Larry was especially upset because of the incident; the utterance in 24 can be seen as a denial of the game as one portraying real warfare. He explicitly speaks of the consequence this incident has had on their way of playing the game as he emphasizes that they had shifted tactics to go after points.

Expressed differently, Larry abandoned a resignation to the game, by denying the game's ability to illustrate warfare properly, and switched to a play style where he at least would win the game by points. By this, Larry enters Gamer Mode because he sees no reason to maintain a professional attitude toward the game.

Neither Larry nor Moe questions the game or tries to find explanations to the event where the artillery battalion got evaporated. The answer was just briefly mentioned in 9 by the instructor who walked by. While this is not picked up by Larry or Moe, we found incidents in which they handled unexpected game calculations differently, even without instructors.

**Situation 2. An overenthusiastic team makes a poor judgment.**

Lee, Mike, and Harry are playing as Opfor in their second round of the game. The NATO units have advanced rapidly to the region outside Cassino, a strategic point to the military operation. A vital part of the Opfor forces has been encircled, and Lee, Mike, and Harry

decide to attack the nearby NATO forces. The group is in quite good spirits; enthusiasm has flourished over the game played so far. Unfortunately, they get severely beaten as they make an offensive attack, resulting in all their vital maneuver units being completely evaporated. Although this comes as a total surprise to the group, they remain resigned to the game as they understand they must have misjudged the situation. Our analysis shows that after replaying the event they suffered from an outlier. We never got the similar devastating results from the game. Outlier or not, their decision to attack was bold, perhaps even foolish, from that position. The game's prediction before the attack (the game aids the players with a prediction of success) said the chances were very poor, so it is evident that attacking was an unwise thing to do even from the game's perspective.

Whatever rationale the group had to attack the units is not as important as what occurred after the event. At first, in a despairing yet humorous tone, the group members shamefully acknowledge their decision to be a really bad one. They quickly switch to a more defensive strategy and move away troops from the front. They do not blame the game or accuse the game of being deficient in calculating the battle-outcome; instead they uphold a resignation to the game. Furthermore, as no instructor was nearby to aid and discuss their experiences, they had to confront and find explanations for the event by themselves. Below is an excerpt 10 minutes after the incident.

1.	Mike	...but it is interesting to see, last time we attacked them many times with smaller units. But now it was because they were strongly co-located...	
2.	Harry	Yes.	
3.	Mike	...that had to be the reason for their criteria for success... <u>and</u> an amount of randomness and luck. Last time we had minimal losses when we hit them with separate platoons or companies.	
4.	Lee	They had time to move away.	
5.	Mike	Mmmmm	
6.	Harry	What we can learn...what we would have done in this situation...I mean, the only thing we could do was to dig in. We	

		could not retreat.	
7.	Mike	So, we should have dug in then....	

Figure 6. Excerpt from a group returning to discuss an unexpected event, making them renegotiate their previous options.

Mike returns to the incident in 1 and compares an earlier game round with the current round. He hypothesizes on reasons for the evaporation: was it a result of co-location of opponent forces? With co-location of units, the opponent forces gained strength by supporting each other during the attack. Mike makes a valid assumption because if they had been more careful and attended to the prediction of the battle-outcome, they would have been aware that this combat was hard to win. In 3, Mike also adds randomness to the reasons for their defeat. Both Lee and Harry agree to this explanation in 2 and 4. Harry emphasizes what they should learn from this episode, where the only feasible move was to dig in (fortify units in current position) and not advance into an attack.

From a learning perspective it is interesting that the group maintained an inquiry into what actually happened, even without an instructor nearby to aid their discussion. They agree on the assumption that randomness and bad judgment on their part resulted in the calculated battle-outcome. Had an instructor been nearby, the cadets would probably have been provided with more immediate feedback on their inquiry process, especially regarding the critical incident where their units got evaporated. They still manage, however, to maintain this inquiry and to link several earlier game experiences into a valid conclusion, which makes the situation an example of cadets being able to critically challenge their understanding of warfare. As a result, this paper argues that critical unexpected calculations from the game can trigger players into challenging their knowledge and beliefs of warfare, without abandoning a professional attitude towards the activity.

### Situation 3. The other side of the game – things go fine

Both episodes above are examples of game calculations being negative to the players. Their opponents experience the inverse, and by analyzing these groups we can identify what influence positive, but still surprising, game calculations have on user responses. The analysis shows that no incidents with positive outcome did affect the players in terms of an observable change of attitude. Neither did the incidents prompt the players to find an explanation, start an inquiry, or question the authority of the game’s ability to do valid battle-outcome calculations.

This did not come as a surprise, as successful moves seldom cause players to investigate the reasons for their triumph. The opposite, however, namely, failure and mistakes, is an important element of learning; it can also contribute to the building of “a learner self”, in which the learner trusts in his or her ability to learn from failures (Kolb & Kolb, 2009).

### BENEFICIAL TO LEARNING OR NOT?

Are we to see unexpected game calculations as beneficial or as a flaw in the learning situation? Generally, this paper argues that these situations are to be avoided, because player attitude could be affected in a negative direction. To avoid this, the inner logic of the game must match the purpose as well as the players’ knowledge. Otherwise players may reject the idea that the game is able to accurately represent warfare, and this will jeopardize the purpose of the wargaming activity by, at least, damaging the learning

worth. Situation 1 above is an example of this as Larry rejects the game's ability to calculate the confrontation between a reconnaissance troop and an artillery battalion. As a result, Larry switches to an attitude where the points in the game are his only concern.

This paper also argues, however, that unexpected calculations can trigger a different user response, in which players start an inquiry process while remaining resigned to the game. The difference between the players' knowledge and the game could, with this response, be described as a knowledge-action gap between the player and warfare (Crookall & Thorngate, 2009). Players then move to a position where they critically challenge the built-in assumptions of the game (Turkle, 1996) and relate this to their own belief of warfare. Players are then inspired to start an inquiry and enhance their understanding of warfare. Therefore, this paper also proposes that these events can be valuable for learning, exemplified in situation 2 where the cadets do not question the results of the game, but instead return to their own beliefs on the effect of co-located military units.

With this somewhat ambiguous finding, further examination reveals a distinction between the two situations in terms of how the unexpected game calculations can be perceived as either plausible or implausible. Situation 1 is an example of the group believing the combat situation to be implausible, while in situation 2 it is less clear as to whether the group believes the evaporation of their unit to be a likely or unlikely event. Perhaps this ambiguity is the reason for the group in situation 2 to start their inquiry and, as they later end up at conclusions where they ascribe the events to be plausible after all. However, what events players perceive to be plausible or implausible is relative to the knowledge they possess on the subject matter. Situations can emerge where players perceive unexpected game calculations to be implausible because the players do not (yet) have the necessary knowledge to grasp the situation. By this, it is incorrect to imply that implausible events are to be avoided at all cost. Educational wargaming aims to enhance and reinforce a player's knowledge on warfare, and this may also include events where the player struggles with implausible events.

### **MASTERING UNEXPECTED EVENTS IN EDUCATIONAL SETTINGS**

Although this paper concerns games used in military education, the same issues are probably also applicable in other domains where game-based learning is used by players with domain-specific knowledge. Similar to the cadets in the study, players in other domains could reject the games' ability to mimic reality or they could critically challenge their own belief of what the game is meant to represent. From this wider perspective, and the premises that unexpected calculations are unavoidable, we speculate on how to manage these events.

First of all, flaws in the game's inner logic can be handled by an informed instructor who can aid discussions and resolve issues. Many surprising events that leave players confused will benefit from an informed instructor who can help players maintain a professional attitude. We found several examples of this in our analysis; the instructor managed to explain surrounding factors, even unmodeled aspects, without destroying the legitimacy of the activity. It seems that players are more willing to accept the authority of the instructors than of the game, and this can provide a valuable resource to keep players on track and maintain a suspension of disbelief. However, we do recognize that instructors are an expensive commodity; to be able to share experience, give explanations and aid discussions requires numerous instructors. In our case, where the surrounding practical reasons required that the cadets play the game simultaneously, it was difficult to have instructors near all game stations.

The role of debriefing is often cited as one of the most important elements of game based learning (de Freitas & Oliver, 2006; Crookall, 2010). As players reflect on actions performed, they are given the opportunity to relate game experiences to real-world concepts and problems. Even though we acknowledge this as a vital part of the process, we argue that debriefing is not the best remedy to attend to this problem because, as in situation 1, players may change their playing behavior as a result of a perceived faulty calculation. Even though these inconsistencies may be corrected at the end during debriefing, the time spent in the game is valuable and, thus, it is desirable to avoid unwanted playing behavior. A better solution is to deal with the problem as it happens during play session and then return to the event during debriefing.

Another factor, often overlooked in individual training, is the significance of other players. If we see educational gaming as a situated activity (Lave & Wenger, 2005; 1991), players are an active part of a learning situation where they use different resources to overcome challenges provided by the game. We could observe many occasions, similar to situation 1 above, when nearby cadets participated in the discussion of strategies to solve the challenges. By this, they became a vital resource for enhancing and reinforcing the players' own knowledge of military tactics. Even though we did not explicitly encourage the cadets to help each other, this was something that grew organically as other cadets tried to solve difficult situations and provide explanations to what happened on the screen.

A final remark concerns the educational purpose of wargaming. The learning objective is not only to enhance the player's skills in tactics and strategy, but also to have him or her learn to accept conditions from the game. In warfare, frictions such as those that arise when surprising events occur are more of a rule than an exception; the earlier players are acquainted with these conditions, the better equipped they will be to face situations in the real world. Perhaps unexpected calculations are to be seen as a valuable tool to prepare officers for the unthinkable.

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