TECHNOLOGICAL EVOLUTION AND PEDAGOGICAL RE-APPROACH TO EFFECTIVE LEARNING USING GAMES WITHIN THE HELLENIC AIR FORCE ACADEMY

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Abstract

The educational policy of the Hellenic Air Force Academy (HAFA) is designed to implement the standard of the Hellenic Air Force (HAF) officer. Our purpose is to specify and design a computer-based war game in order to use it as a tool for a) applying our educational policy; b) advancing the professional training of the students of the HAFA; c) assessing the behaviour of future officers in relation to the intended standard; d) understanding and resolving applied ethical questions. The game will also be used for professional informal continuing education in a distance learning environment, for promoting cooperative learning and the development of virtual communities of practice within HAF.

Advantages of Using Games in Learning

It would be advantageous to have a series of games and other educational activities other than classes (e.g., simulations), which, combined with formal education, would all contribute to a common educational goal. It is our intention to design an educational serious game which will help our graduates comprehend the mission of the HAF officer, as defined below. In this paper we are going to present the design issues of a strategy game, where the player assumes a particular role and has to make certain choices at any stage of the game. These choices could be either deterministic or non-deterministic, in which case the next stage would be expressed in a form of a utility function (Garris & Ahlers, 2001).

Our approach is: At first, a number of teaching methodologies, used to make ethical decisions concerning the conduct of war will be examined. For example, one can attempt to resolve military ethics dilemmas faced by contemporary armies with reference to war literature and poetry or by using philosophical texts relating to them. Another option is to refer extensively to the legal aspects of these dilemmas citing the provisions posed by International Humanitarian Law and each nation's military legislation. Also, we can discuss moral issues with reference to a

particular theory (i.e. the just war theory (Brown, 2003)) and of course we can rely upon a number of case studies to make our students confront difficult questions like: "what should be done in this case?" or "which elements could help me decide which is the best choice?" or "how can I calculate the likely outcome of my actions?" Our aim is to show that we need a new pedagogical approach towards reflecting on military ethics, if we want an effective, ethical leadership and a conduct of hostilities according to moral and legal rules of war.

Secondly, the basic concepts of simulation and gaming, as well as their applications to strategic and tactical decision-making are examined. We attempt to show that employing games one can: a) determine the tactical options available to each side; b) assign a numerical value to each possible outcome; c) calculate all possible strategies and their outcomes; d) find each side's best options at strategic and tactical level; e) determine the expected result of the game, by examining whether the possible outcome favors the attacker or the defender and finally, f) evaluate each player according to their choices.

How to Teach Military Ethics?

As noted in the introductory section, literature and philosophy can be used to the officers' ethical training. War literature (Sherry, 2005; Thompson, 2004) and poetry (Stallworthy, 2003) related to warrior ethos, the conduct of hostilities or other, specific aspects of war (such as the treatment of prisoners of war or the protection of civilians) can be an excellent source for locating and commenting on ethical dilemmas concerning war. Many ideas expressed in religious and philosophical texts are now part of International Humanitarian Law (Nabulsi, 1999; Tuck, 1999). Undoubtedly, texts play an important role when discussing ethical dilemmas; they can provide us with a historical approach of the moral issues that are under consideration nowadays. Analysing texts may prove a positive element and precious supplement when thinking what action one should take in war, but alone can not help officers or soldiers to solve practical ethical problems. One needs a more systematic approach to deal with them efficiency.

Another step forward, moral theory can provide us with a useful framework, essential in our efforts to think about ethical dilemmas in a more organised context. For example, *just war theory* has a long history and flexibility to deal with a variety of situations; it covers a variety of topics, some related to the beginning of war (*jus ad bellum*) and some related to the conduct of hostilities (*jus in bello*). The problem with this approach is that there is no moral theory of any kind which can give as all the answers to every possible problem that could arise. Decision-making in a war is not an easy task. Moral theories can help military and political

personnel in charge of planning this kind of operations to realise the ethical perspectives of their choices.

Another way of reflecting on ethical dilemmas and ambiguous cases is by resorting to the legal framework of war. In fact, a subset of moral rules with the lapse of time formed the moral baseline and actually became a part of the International Humanitarian Law (IHL). Let us think about tactical planning in a populated area. Is everything permissible in order to achieve the objectives set? Are there legal obligations towards civilians' protection? By using IHL, we can also analyse the use and limitations of specific types of weapons, as well as how their use can guarantee the best possible result, on both moral and practical grounds (Lekea, 2006). Is this sufficient though? The answer is negative as both ethical theories and international legislation tend to be rather generic by nature; hence, unable to deal with situations where a large number of interdependent factors are involved. The combination of ethical theories with international legislation can provide us with valuable directions on which the operation will be based, but can do very little with helping us to design and run it.

Games and simulations, on the other hand, will allow us to cater for these aspects as well in the form of a strategy, assuming rational players with incomplete information about one another abilities, which is true in almost all cases. The application of game theory and simulations to the study of war can be of great help (Haywood, 1951; Myerson, 1997; Shubic, 1983). They can provide us with the tools necessary for studying practical issues about the costs and benefits of a war, evaluating ethical questions on the use of force in the battlefield or in urban environments where the protection of civilians is crucial (e.g. fire exchange in the war against terrorism or humanitarian interventions). Game theory and war games (Jayakanthan, 2002) prove to be necessary in strategic and tactical decision-making (Colman, 1982; Hastie & Dawes, 2001; Isaacs, 1965; Osborne, 2003). At the strategic level, we can apply those theories and use games to decide when it is best to start (or end) a war, or even take an alternative political or diplomatic course of action according to the calculation of benefits from our actions. Military planners can also apply game-theoretic analysis to tactical operations since it enables them to estimate and confront effectively the capabilities and military choices of the enemy, evaluate how an intelligent (and rational) opponent is likely to behave in a given situation and which side is most likely to win.

Video Games and Learning

Many good video games incorporate a whole set of sound learning principles, strongly supported by contemporary research in cognitive science. Therefore, learning promoted by video games often exceeds the game playing period (Gee,

2003). Video games employ traditional educational concepts such as tutorials and assessment (mostly in the form of *scoring*). Tutorials present the player with the basics of how to control and interact with the game and then test the player on this information with a series of missions. Often, tutorial missions introduce gradually new features or play elements, to avoid overwhelming the player. By the time the player has completed these first few missions, he or she has "learned" the essentials of the game and can be provided with ever greater in-game challenges (Chen & Michael, 2005). Although tutorials sound like familiar terms to educators, we have a lot to learn about learning from good computer and video games (Gee, 2003). Some important educational features of video games are:

- Information "on demand" and "just in time". A common mistake in education is that too much information is offered out of the contexts of actual use or apart from students' purposes and goals. Good games invent ways to put information inside the worlds the players move through, and make clear the meaning of such information and how it applies to that world (Gee, 2003).

- Good games are pleasant and exploit in the best way the power of multimedia. Screens with moving content and sound immediately capture young peoples' attention. The current generation of students is so familiar to video games and that's why it is important to use them in education (Prensky, 2001).

- It is noteworthy that many video games achieve the players' commitment till the end, a characteristic so much desirable in education. Motivation leading to commitment is the most important factor driving learning. A simple definition of motivation is a learner's commitment to engage in a new area of learning (Gee, 2003). It is important to find out how good games manage to create and sustain players' motivation**.**

- A significant and promising feature of modern games is their *adaptability*. They are capable of monitoring the player's actions within the game, in order to adjust several features such as storylines, strategies and other variables. Games may adapt to players in various ways (Chen & Michael, 2005; Gee, 2003). This becomes even more important if we want to take into account the various *learning styles* (Honey & Mumford, 1992). Teachers always have the same teaching style which always favours the same group of students, having that particular learning style. In games we could adapt the learning style, in the same way we can do it in e-Learning settings (Grigoriadou, 2006); we can also add more and more missions to specific players which

seem to learn a specific lesson difficulty, until they have reached the desired level (or, according to desired standards, as explained below).

- The underlying technology can promote many desired skills such as cooperation, sharing of knowledge, assumption of new roles (Gee, 2003). For instance, it is common to have players play in multiplayer mode, via networks or the Internet. It is also common to put them collaborate in teams, towards a common goal or mission, each using a different but overlapping set of skills. In such settings, players cooperate and share information, knowledge, skills and values with others (Wenger et al., 2002]) In this respect, games may be preferable to formal studies for preparing today's workers.

- Good computer and video games allow people to learn effectively while recreating themselves in virtual worlds (Gee, 2003).

- Game-Based Learning is extensively being used by the U.S. Armed Forces (Prensky, 2001).

HAF Officer Standard

The purpose of education at HAFA is to produce officers according to pre-specified standards by the Hellenic Air Force General Staff. In order to determine the parameters of the game, we have developed the "typical standard" of the Greek Air Force Officer. Its development is based on the officer's evaluation report (official document of the Air Force General Staff Office), as well as the legal framework that determines the appropriate behavior of an officer in times of war and peace. The legal documents refer to both official Greek Texts (Greek Military Law, orders relating to internal Air Force procedures), as well as to international humanitarian law. Finally, an important role in the development of the game was played by the doctrine of the country which is based on defense.

The major *assessment axes* are:

- mental abilities (judgment, analytical and critical thinking, intelligence, critical decision making);

- spiritual qualities (courage, team working, initiative);

- management qualities (interest for their subordinates/sound judgment for their involvement in the operations, leadership capabilities, ability to predict developments and co-ordination);

- professional qualities (professionalism of moves, efficiency of choice, interest in protecting his soldiers and any other available inventory);

- moral qualities (punctuality, dignity, sense of responsibility, serving with knowledge and respect of his mission, justice, making choices on the sole basis of qualities and evidence, discipline).

All these qualities are related to one another and evaluated with regards to the legal framework of war, as this is determined by the international treaties and conventions. As an example, the trainee has to restrict the use of weapons and war tactics (no nuclear, biochemical and weapons of mass destruction, no weapons that can cause disproportional damage to civilians and the environment, no tactics that can cause exorbitant pain to the opponent, observance of the principle of distinction and proportionality). Finally, in relation to the war doctrine, the emergence of hostilities should be related to reasons of defending and safeguarding national interests. The trainee, thus, has to try and act in accordance to the rules of the game when making his choices; cadets will be evaluated positively when they follow the standards (as this was described earlier) and negatively when they do not take them in consideration.

Assessment Issues

Assessment is probably what students hate most in education. Serious games represent an opportunity to change this fact, by providing alternative types of assessment, far away the simplistic, boring and narrowly focused testing provided by multiple-choice questions. In fact, they can do so by combining other forms of traditional assessment with methods modern video games now use on a regular basis. The goal should be to create pleasant, more complex and complete types of assessment than have ever been available before. Towards this goal, game designers and educational professionals need to work together in developing serious games as a new teaching tool (Chen & Michael, 2005).

Assessment Challenges

Despite their success using educational methods such as tutorials, game designers and developers must recognize their own limits when it comes to serious games. The use of serious games in education creates certain challenges that can make assessment difficult:

- With less emphasis on rote memorisation of facts, the assessment obtained from traditional methods may not accurately reflect the learning gained from serious games.

- Open-ended simulations can support a wide range of possible solutions. But which one is the best choice/catch?

- When teaching abstract skills such as teamwork and leadership, how do you measure learning and/or improvements? etc. (Chen & Michael, 2005).

Because serious games have such challenges, their developers have turned to more sophisticated assessment methods. The main types of assessment used in serious games (Chen & Michael, 2005) are the following:

- Completion Assessment; did the player complete the mission or pass the test?
- In-Process Assessment; how did the player choose his or her actions? Did he or she change their mind? If so, at what point? And so on.
- Teacher Evaluation; based on observations of the student, does the teacher think the student now knows/understands the material?

Scoring

The typical form of assessment in entertainment games is scoring. Games often offer comparisons between players with high score lists. The scoring system teaches the player what is important within the game; a positive score indicates a good choice, a negative score indicates a bad choice, and no score at all indicates that the performed action was probably unimportant. In this way, it is similar to the educational strategy of "teaching to the test", which explicitly identifies to the student what is important to learn and what can be ignored (Chen & Michael, 2005).

What's wrong with scoring? The problem of scoring is that it gives a "one-dimensional result." That is, it does not assess various virtues of the player individually, so that we cannot get detailed information about the player's skills.

Log Files

Video games often use log files to monitor player's action. Log files may track data like: i) Time required to complete the lesson; ii) Number of mistakes made; iii) Number of self-corrections made; and more (Chen & Michael, 2005). Such information is useful to teachers. Teacher evaluation may also be performed by observation of the students while playing the game.

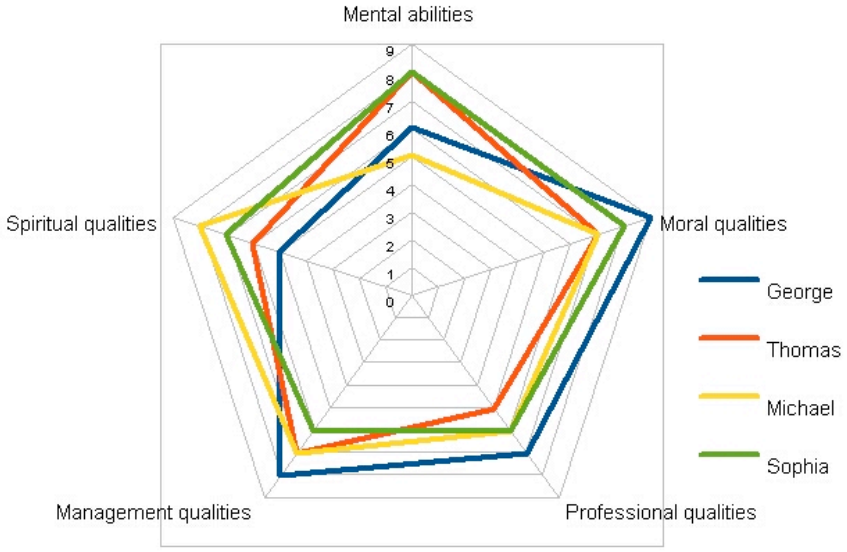
In our case, we plan to use the following framework:

- Did the player complete the mission?
- Did the player follow the rules (laws, ethics etc.)?
- Where there any losses and to what extent?
- Did the player make correct decisions and to what extent? Did he/she arrest the best action plan? Did he/she select the right weapons? Did he/she exploit all their forces, advantages, allies etc., and to what extend?

From the aforementioned discussion, it comes out that the ideal HAF officer should have some specific virtues, such as those discussed above. Assume that one player may perform well in some of the above issues and badly in some others; it is possible that this player may get the same score with another player who succeeds where the first player fails and vice versa. With a "flat" scoring scheme, we shall not be able to tell the difference between the two players. What is of utmost importance, we shall not be able to give detailed directions for improvement. Thus, what is needed is to assess each issue separately; then, given the possibility of game adjustment to players' competence, we could design the game to present new challenges to each player, in order to help them improve particular skills. We have called this feature "multidimensional assessment".

It would be desirable to produce officers that will be perfect in all the main guidelines ideally; but this is unrealistic. Instead, practically we should try to reach this goal as close as possible. Nobody is perfect everywhere, but he/she is good somewhere and less good somewhere else. Thus the purpose of education becomes how to strengthen one's weaknesses, since he/she is a ring of the whole chain, and the strength of the chain is that of its weakest ring! Under this perspective, education should be personalized to each one's needs. Thus, the same must hold for games, and this is a point where technology helps! Helps not only identifying one's weaknesses, but also their learning style, and helps in adapting the game accordingly. The following picture presents possible scores of four different players as far as the aforementioned assessment issues are concerned.

Figure 1: Sketch of Multidimensional Assessment



Most video games would provide a flat assessment score, which would not give much useful information to teachers attempting to identify, improve and enforce players' weaknesses.

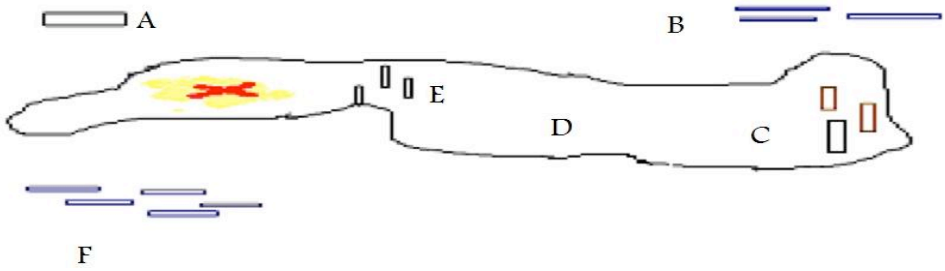
Case Study

Final year cadets at the Hellenic Air Force Academy have taken all courses of international legislation, inventory and staff management as well as the leadership module; therefore, we can safely assume that they possess the theoretical framework for judging, evaluating and selecting their moves. In the context of this research, they were given the following problem.

The Scenario of our Game

Let's assume that you are in charge of operations. In the drawing below you see the position of a suspect target in a "grey" area inside a civilian area. The time you have is very limited, the situation is extremely critical and the forces that you can use are those depicted in the drawing (Figure 2). How would you use your leadership skills, in order to effectively use the technological powers available? How would you mobilise your human resources? What factor would you pay more attention to: technical or human resources?

Figure 2: Map of the Various Forces Listed in the Scenario



Your target (marked with X) refers to an assumed terrorism operation centre. We do not know exactly what types of weapons they have there, but there are some reports suggesting the existence of biochemical weapons. You have twelve hours in order to collect additional information, to organise and run the mission. The resources you have are as follows:

- *In point A there is an aircraft carrier armed with photographic and other aircrafts with various abilities as well as helicopters.*
- *In point B there are vessels that carry armed soldiers, which after disembarking a company of artillery and a troop of infantry at point C, they are back to their bases.*
- *In point E, there are Special Forces, carried there by the helicopters.*
- *In point F, there are frigates and fast attack vessels in supporting roles.*

Please, take into account that, because of rough areas (in point D), there is a danger for the company not to make it in time and to be out of range for the operation as well as for the armoured vehicles not to be at point X (target) in time, i.e. within the twelve hours available.

After the class was split in two groups, one group looked at the choices of the army and the other one the choices of the terrorists. In relation to the above discussion, the evaluation of the results was made on the basis of:

a) observing the rules regarding to the principle of the distinction;

b) observing the rules relation to the principle of proportionality;

c) the appropriate use, management and protection of resources.

In the very interesting discussion that followed the presentation of the choices made by the two groups, the cadets admitted that their understanding of the complexity of the modern operations environment was improved with the use of

the game, as well as of the difficulties of observing principles and rules of justice and morality. The options of the players were discussed in detail in a series of lectures that lasted for a long number of hours with heavy participation of the cadets, while comments on the current legal and moral framework were made (e.g. whether they need updating or not).

The key issue is that with the use of the game, the trainees played the role of commander and had to make choices (Bisson & Luckner, 1996). They did not have piecemeal solutions to choose from. They followed a procedure of thinking and resolving the problems and faced the consequences of their choices as if they were responsible for their choices in a real battlefield. In short, they got into the shoes of a commander, with any mistakes due to their short experience. The benefit, however, was much more important: they got into the process of thinking, selecting and taking responsibility for their actions.

The Design of a Serious Game for HAF

In relation to the above, our aim is to develop a game for use by the module of philosophy and ethics of war (Ravenscroft & Matheson, 2002). In this game, our aim will be to evaluate the choices of the trainee cadets in relation to the standard of the Greek Air Force Officer (Amory, Naicker, Vincent, & Adams, 1999).

The main idea is to foster the thinking and reaction of trainees, by giving them challenging scenarios, where their choices for army movements may have a high cost (Aldrich, 2004). They have to choose the best tactics for achieving their target with the least possible losses (logistics issue), as well as the least possible consequences to their subordinates, to civilians and the environment (legal concerns, as well as moral and war doctrine issues). Because there are no easy or right and wrong choices, the participants in the game have to negotiate and maybe change their initial thoughts and choices, which is a way of realising the responsibility they will be having when the time does come that they will have to take part and act in similar missions. As already mentioned, their evaluation will be based on legal documents, orders and official documents issued by the Air Force General Staff Headquarters, as well as the moral values of the force (and are described in documents such as the Air Force cadet's manual and the oaths they take when entering into and graduating from the academy).

The schedule is to incorporate the game into the module (after some introductory lectures) and to use it as the main tool for evaluating the trainees. In order for this to happen, we shall need to define exhaustively the moral and legal framework of the game (implementation period of about 6 months). Following that, working closely with senior officers we shall develop the scenarios (implementation period of about 6 months). Finally, the coding of the game will take about 12 months. We

expect to use the game for the final year cadets in the spring term of 2011.

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