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Evaluation of the marine game Simple Surface Warfare Model

Topic 6: Experimentation, Metrics, and Analysis or Topic 5: Collaboration, Shared Awareness, and Decision Making

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Evaluation of the marine game Simple Surface Warfare Model

Wargames are nothing new and used by most countries in one form or another. Here, evaluation of a game called Simple Surface Warfare Model was developed to train cadets and test military plans. Our purpose with the study was to evaluate SSM as a wargame, to see strengths and weaknesses. The game was tailored for learning basic marine tactics and at the same time be engaging to use. In a two week exercise, 27 cadets divided in four staffs, planned and executed a marine mission. Surveys were used to evaluate concepts of training, experience, feedback, influence on the real situation, and immersion. Also, researchers and trained military instructors evaluated the cadets performance during the exercise and during the after action review. The results show that the cadets gave overall high ratings for the concepts, but significant lower for influence on the real setting. All together, this the first major wargame with SSM, was a success. Especially interesting and important is that SSM worked to teach the cadets basic marine tactics and at the time proved to be engaging.

1. Background

The use of wargames to train and educate military personnel are not something new. However, there were a major conceptual change early in the 19th century where direct representations of military forces were used (Granberg & Frank, 2010). The Swedish Armed Forces define wargames as (Försvarsmakten 1999);

”Staging of a wargame or war scenario with a minimum of two antagonistic sides, where the outcome is affected by both sides actions.”

The Swedish Armed forces, as other nations, use different wargames to enable soldiers and officers to train various aspects within their branch that otherwise would be too expensive or impossible to perform. Such reasons could be that it is hard to coordinate exercises between the branches, it is often impossible to train the exact same thing multiple times and sometimes it is simply too dangerous. Another major advantage with games is the possibility to train specific elements, e.g. focus on tactics or an overall understanding of the battle arena. Also, the training can be made more effective since it is relative easy to customize a specific training program for one individual or for a military course. In a real situation, that kind of customized training program would probably be too expensive or for other reasons impossible to conduct.

Brewer och Shubik (1979) divide wargames into four categories, education/practice, operative, research, and amusement. The purpose, why the wargame is used, should have major impact on the attributes and features of the game. One such feature is realism. In many situations it is not necessary to spend tremendous amount of money to make the wargame realistic since the purpose might be of basic character or perhaps team work. A common approach is to mimic reality to such an extent that the

wargame are filled with features, all with high fidelity. A problem with these wargames is that they are often cumbersome to use and requires much effort when deployed in training. An alternative approach is to develop the wargame for a specific task and only include those features necessary to meet the training and educational objectives. Garris, Ahlers & Driskell (2002) points to the importance of an engaged user and learning content integrated with the game. A well conducted exercise should enable motivated and engaged learners.

SSM (Simple Surface warfare Model) is a wargame that was developed by the Swedish National Defence College based on two approaches; a game that is tailored for learning basic marine tactics and simultaneously being engaging. Here, we were interested if this approach was successful.

In an exercise, marine cadets played SSM as part of their course in marine and amphibious warfare tactics with purpose to train tactics and evaluate their plans. Our research purpose and focus in this paper was to evaluate SSM as a wargame to see strengths and weaknesses.

2. Method

2.1. Participants

27 cadets divided in four staffs, and two instructors, all from the Swedish military academy Carlberg participated in the experiment.

2.2. SSM

In SSM a player can take different roles, e.g. the commander lead the planning and execution of a marine operation. Missions can be used in different environments and multiple marine vessels can be adapted, e.g. boats, submarines and helicopters. During the execution of a mission the commander gives orders to his staff how to move the units, use of sensors, and when weapon should be used (e.g. robots). Both blue and red side can be played, and both sides have to take into account green actors (civilian). Also, rules of engagement (ROE) can be used to dictate the rules of war in the scenario.

To make sure that the participants focus on the tactics some parts were automated. Also, some otherwise substantial and important work was automated, like putting together different information sources to get an overall picture of the air-, water-, and underwater situation. This information, aggregated in situational pictures on the map provides the basis for the players' different decisions. The automated functions were not always identical to the real situation, but resembled the real overall setting.

SSM consists of a large map where the different units are visualized, a small overall map in the upper right corner, and function structure with information and interaction possibilities in the lower right corner ([Figure 1](#)). To move own forces the player drag the object to a new destination and as a result it moves realistic towards the new position. There are numerous possibilities to affect speed, defence, weapons, and the use of sensors but these functions will not be described in further detail here.

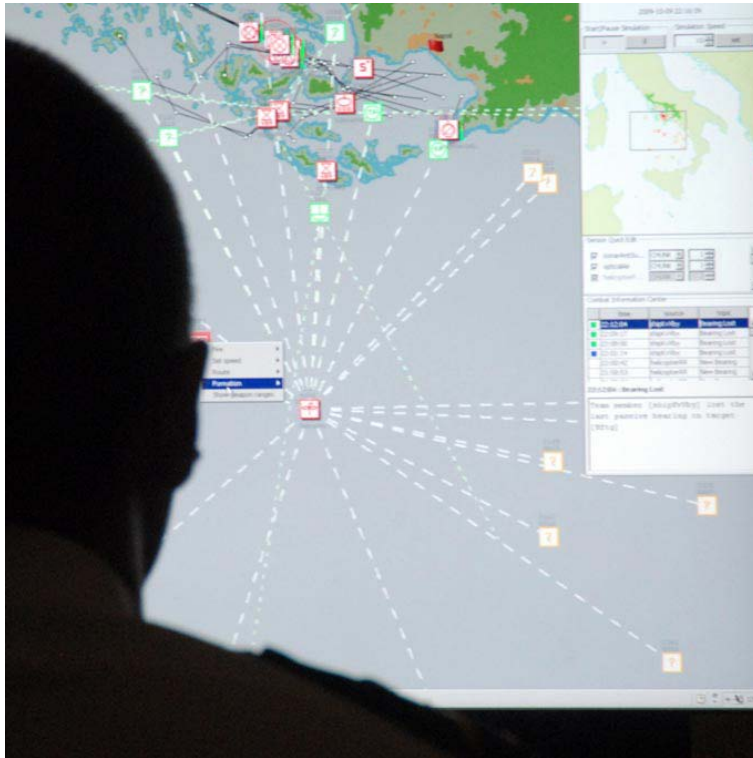


Figure 1. SSM with the large map, including an identified red vessel with bearings to civilian (green) and unidentified (yellow) vessels. On the right hand side is the small overall map and tools for interacting with the game.

2.3. Experimental design and procedure

The experiment explored cadets and instructors experience of SSM regarding five concepts; learning (7 questions), experience (8 questions), feedback (4 questions), influence on real situation (2 questions), and immersion (2 questions). A questionnaire was used, including questions with 7-point ratings scales and open questions. The questionnaire was developed at FOI and has been used in earlier similar studies (Nählinder, Oskarsson, Lindahl, Hedström, & Berggren, 2009; Oskarsson, 2010). The concepts are based on important factors that have been explored in other research (e.g. Garriss, Ahlers, & Driskel, 2002; Wiese, Freeman, Salter, Stelzer, & Jackson, 2008; Witmer & Singer, 1998).

The experiment had three major phases; preparation and making military plans (5 days), introduction and practice with SSM (1 day), and conducting the wargame session with SSM (2 days). The week before the game execution, the staffs prepared plans to play both blue and red side. The mission was from a starting point in the sea, use own forces in a tactical smart way and disembark troops in three possible harbours on mainland. The maritime terrain was an archipelago where it was possible to hide boats among the islands. Red forces task was to protect the harbours. During the introduction and practice the cadets got information about the experiment and SSM, and also played two practice scenarios. During the last phase, wargaming, the staffs played four scenarios, commanding blue and red side once each day. Four staff rooms were used with three SSM-clients installed in each room, one for the commander and two for the staff members ([Figure 2](#)).



Figure 2. Staff room with the commander handle the overall view, while the other cadets are divided between two SSM clients (only one client is visible in this picture).

The military instructors supervised the planning before the operation, and supported two staffs each during the experiment. Support during the game included minor comments and answering technical issues.

After each day there was an after action review with two staffs together (blue and red side), where the instructor, researchers and technical personnel participated. Tactical issues were discussed, where blue and red side explained their tactics and by this both sides could learn from the situation. Furthermore, the instructor gave feedback and questioned decisions when necessary. The after action review was a complement to the questionnaire that both cadets and instructors answered after the last day.

3. Results

An analysis of variance was made to see possible differences between the five concepts. Also a descriptive analysis was conducted for each concept, and a comparison between cadets and the two instructors rating was made. The questionnaires open questions are summarized and described. All together, these analyses and the after action review gave us a good understanding of how SSM worked.

3.1. The Concepts

An analysis of variance (ANOVA) with five concepts was made. To calculate the mean for each concept, the values for the questions of the concept were used. Tukey HSD post hoc test was used to further analyze statistical differences.

The ANOVA showed a significant effect of concept $F(4, 100)=9.08, p < .001$ (Figure 3). The Tukey post hoc test showed that influence on real situations was rated lower than learning ($p < .05$), experience ($p < .001$), feedback ($p < .001$), and immersion ($p < .05$). Overall, the ratings were fairly high (above five), except for influence on the real situation.

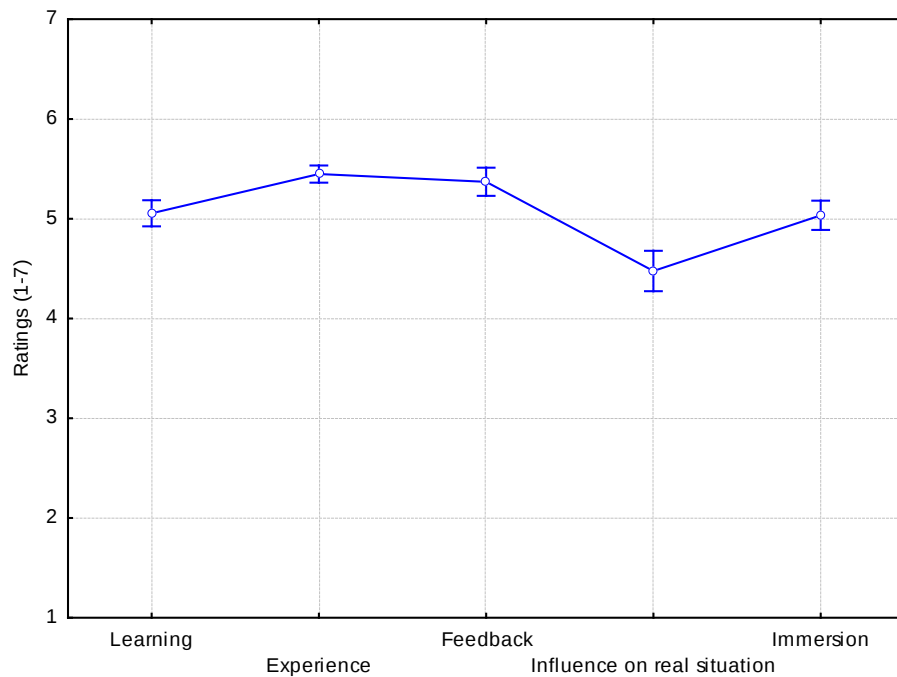


Figure 3. Mean and standard error of mean for the five concepts.

3.2. Descriptive analysis of the questions included in each concepts

Seven questions investigated how the cadets experience learning in SSM. The results show that staff-related work, real exercises, and hard elements are rated lower than marine tactics, new situations, and situations that cannot be trained in real environments. On the overall question how much the participants learned playing SSM the rating was 5.3 ([Figure 4](#)).

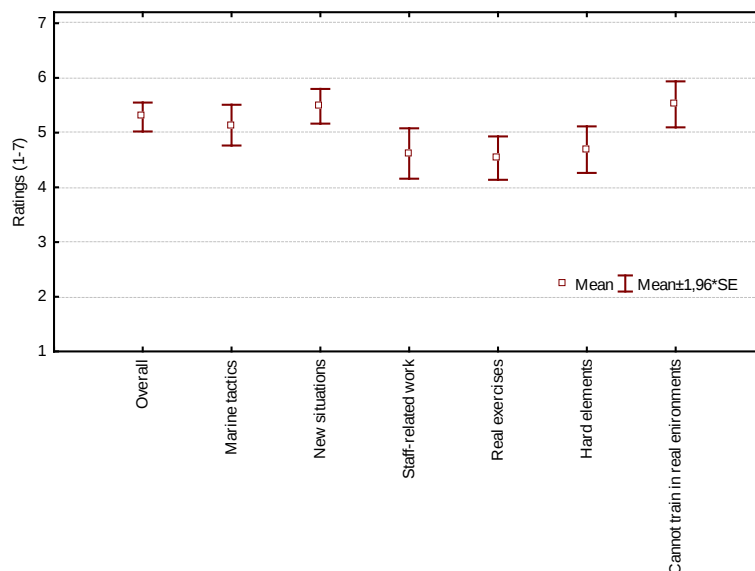


Figure 4. Mean and standard error of mean for the seven questions included in the concept learning.

Eight questions investigated the cadets' experience playing SSM. The ratings were about 5 and above. The overall experience and how motivating it is to play SSM were above 6 on the 7-grade scale ([Figure 5](#)).

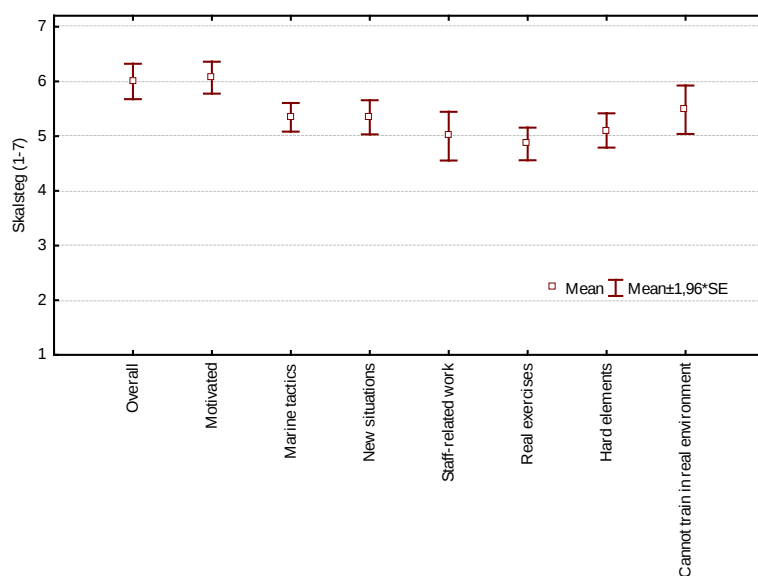


Figure 5. Mean and standard error of mean for the eight questions included in the concept experience.

Four questions investigated feedback the cadets got from SSM and instructors. Feedback from the simulator was rated lower than from the instructors, both for quality and quantity ([Figure 6](#)).

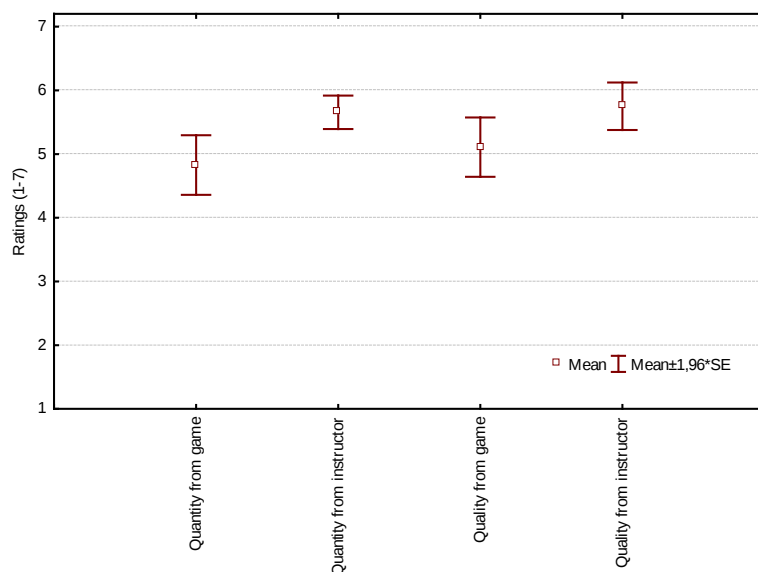


Figure 6. Mean and standard error for the four questions included in the concept Feedback.

Two questions investigated the simulators influence on real situations, and two questions immersion. The ratings show that cadets believe something could get harder in real settings after using SSM. To better understand this, comments in the open questions are considered (see below). Also, the cadets believe that things could be easier in a real setting after using SSM. Ratings whether SSM was realistic was on a medium level. The highest rating, above six, was for how engaging SSM is (which was easy to observe during the game) ([Figure 7](#)).

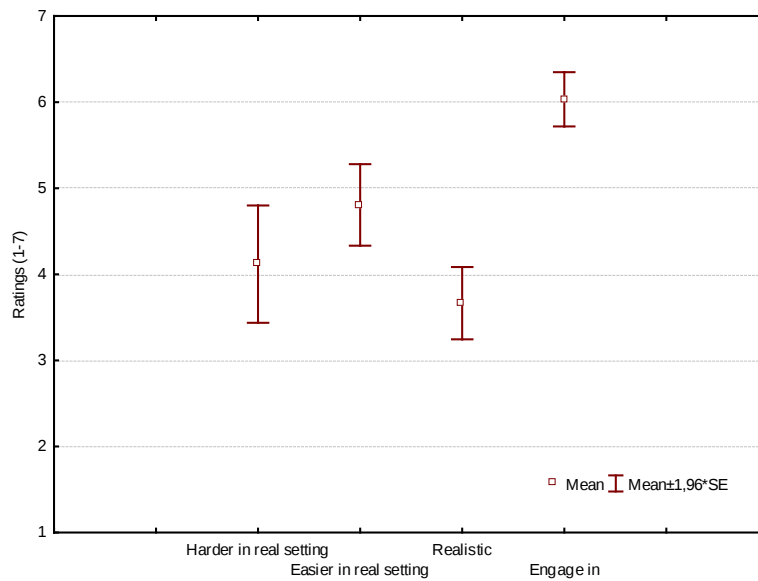


Figure 7. Mean and standard error of mean for influence on real situation and immersion.

3.3. Comparison between cadets and instructors ratings

The instructors were asked to rate cadets learning, experience, etc, and a comparison were then made with cadets own ratings. No statistical analysis was made since there were only two instructors. The purpose was to get an overall understanding of data. The result shows that learning, feedback, and influence on real situation matched well. Cadets rated the concept experience somewhat higher than the instructors (Figure 8). The reason for this difference is unclear, but a possible explanation is that the cadets were somewhat overoptimistic while the instructors with many years of both real and simulated experience had a more balanced view of the training in SSM.

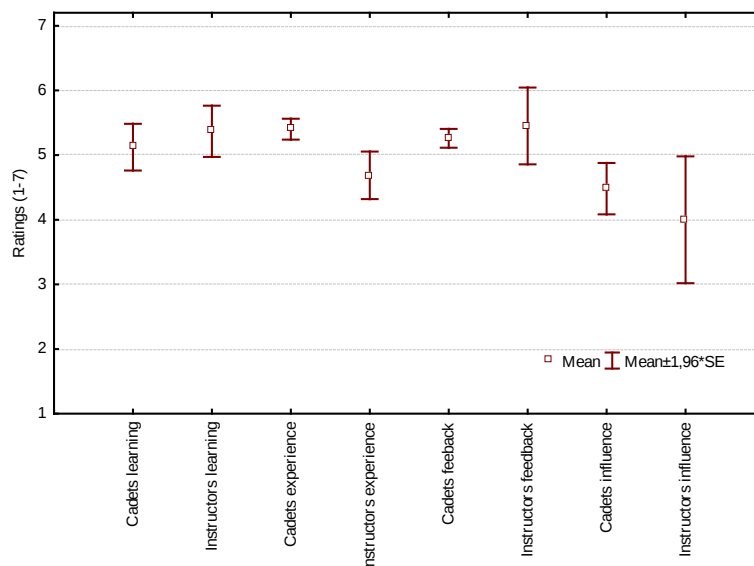


Figure 8. Mean and standard error of mean for the comparison between instructors and cadets ratings for the concepts learning, experience, feedback, and influence on real situation.

3.4. Open questions discussed by cadets and instructors

The focus here is if anything gets easier or harder in the real military setting by using SSM. Also some overall conclusions from the open questions will be presented. These results are summarized and are not presented in detail.

Cadets

What things will get harder in real situations after the training with SSM?

- Situations and abilities in SSM that does not match real life (no specific problem mentioned).
- Sensor and weapon abilities do not always match the real situation. There is a risk for incorrect learning in the simulator situation.
- Since SSM help the user with some underlying algorithms and aggregate information this might give the user a false understanding of how the real setting works. The configurations or algorithms should match the real setting.
- There is a risk that the participants see the game situation as fun rather than an important opportunity to learn abilities in their role as marine officers.
- The complexity in SSM is not always in accordance with reality.

What things will get easier in real situation after the training with SSM?

- An overall better understanding of the marine military situation.
- Better understanding for marine tactics since we planned and carried out the plan against an opponent in the SSM scenarios.
- Better understanding for sensors and weapon abilities, such as weapon reach and effect.
- It makes planning easier since the same military planning process was used preparing the SSM scenario as probably will be used in a real setting.
- Understand the real situation better.

Instructors

What things will get harder in real situation after the training with SSM

- Ethical decisions for own-, enemy-, and neutral forces. It is easier to take a hazardous decision in a simulator, but at the same time it gives participants the possibility to reflect about the decisions.
- There are numerous of factors and situations that is not tested, practiced, and experienced in an office setting.

What things will get easier in real situation after the training with SSM?

- Decision-making, since the cadets practice this and have to make the decisions from different basic data.
- Overall, decision-making and the ability to take the whole situation into account gets better.

Other comments and reflections;

- The simulator is realistic regarding decision-making since the cadets sometimes had to make decisions based on insufficient facts (as could be the case in real settings). An alternative for the cadets is to work and figure out more facts before taking decisions. The preparation with their plans is of major importance to make sure the game works as intended.

- It is important with preparations for the instructors. Protocols with questions and a coordinated view both for SSM and game procedure with game-command is of importance.

4. Discussion

The concepts; learning, experience, feedback, immersion shows that both cadets and instructors believe that SSM can be a valuable tool in cadets education and training to become marine officers. The concept influence on real situations was rated significant lower than the other concepts, which is especially interesting since cadets have very limited experience from real military marine situations. One possibility is that the cadets was unsure how to rate this concept, and therefore rated it in the middle.

Another possibility is that the training in SSM has a limited positive influence on real situations, however other research shows that even if the game realism is limited it can be motivating and give valuable training (Oskarsson, Nählinder, & Svensson, 2010). Stanton (1996) also points out that game training is most effective in dynamic environments (e.g. vehicles, tanks, boats), which was the situation here. Nählinder et. al. (2009) also reports that training in systems with multiple users such as dynamic decision-making is valuable, which also was the case in this experiment.

The wargame worked well and were appreciated both by cadets and instructors. After the three-day exercise cadets asked to have SSM clients installed on their personal computers to be able to practice more on evenings and weekends. They wanted to have the possibility to try different scenarios in different environments. The overall opinion from cadets, instructors, researchers and technical personnel was that SSM can successfully be used in this kind of training. One major and important part of the experiment was the planning phase before the actual wargaming. This guaranteed that the cadets were prepared from a tactical planning perspective and could focus on learning technical game issues the first day. Then, when playing SSM against an opposing force, they carried out their plans to see if the plans were consistent with their expectations.

During this game the cadets played against other cadets, and were really motivated. Other interesting possibilities would be to let the cadets play against more experienced marine officers or against prepared scenarios. The later would from an experimental point of view give us as researchers' better control of the situation. Methodically there are some possibilities to further improve the game, e.g. logging data for different performance measures which could complement the subjective ratings from both cadets and instructors.

Our purpose was to evaluate SSM as a wargame to see strengths and weaknesses. All together the subjective ratings, answers from open questions, and comments during the exercise show that this, the first major wargame with SSM, was a success. Especially interesting and important is that SSM worked to teach the cadets basic marine tactics and at the same time being an engaging game.

5. References

- Garris, R., Ahlers, R., & Driskel, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33(4), 441-467.
- Granberg och Frank, 2010. *Krigsspelande – En introduktion samt nulägesbeskrivning inom Försvarsmakten*. 97/20009:3. Ledningsvetenskapliga Avdelningen Militärvetenskapliga Institutionen Försvarshögskolan.
- Försvarsmakten. (1999). *Nomen FM*. Remiss HKV 09 9111:66532. Försvarsmakten, 1999.
- Brewer, G. & Shubik, M. (1979). *The ware Game: A critique of military problem solving*, Massachusetts. Cambridge s.32-39.
- Nählinder, Oskarsson, Lindahl, Hedström & Berggren. (2009). *Effects of simulator training – motivation factors*. FOI-R—2926—SE. Linköping.
- Stanton (1996). Simulators: a review of research and practice. In N. Stanton (ed.), *Human factors in nuclear safety* (pp. 117-140). London: Taylor & Frances.
- Oskarsson, P-A. (2010). *Training in the CV90 simulator*. FOI-R—3145—SE.
- Oskarsson, Nählinder, & Svensson. (2010). A meta study of transfer of training. In *Proceedings of Human Factors and Ergonomics Society*.
- Wiese, E. E., Freeman, J., Salter, W. J., Stelzer, E. M. & Jackson, C. (2008). Distributed after-action review for simulation-based training. In Vincenzi, Wise, Moulana, & Hancock (Eds.). *Human Factors in simulation and training* (pp. 287-299). Boca Raton, FL: CRC Press.
- Witmer, B. G., & Singer, M. J. (1998). Measuring presence: Teleoperators and virtual environments: A presence questionnaire. *Presence: Teleoperators and virtual environments*.

The background of the slide features a silhouette of a person's head and shoulders in profile, facing right. They are looking at a computer screen. The screen displays a map of a coastal region, likely the Baltic Sea, with various islands and landmasses. Overlaid on the map is a network of red and green squares, some with numbers inside, connected by thin black lines. A series of dashed white lines radiate from a central point on the map towards the right side. A small, semi-transparent menu box is visible near the center of the screen, containing options like 'File', 'Set speed', 'Pause', 'Transition', and 'Show/Hide map'.

Evaluation of the marine game Simple Surface Warfare Model (SSM)

Patrik Lif - Swedish Defence Research Agency
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Background

- Wargames is nothing new but in the 19th century direct representations of military forces were used.
- The Swedish Armed Forces define wargames as;
"Staging of a wargame or war scenario, with a minimum of two antagonistic sides where the outcome is affected by both sides actions." (Försvarsmakten 1999)
- Reasons for using wargames can be education, practice, operative training, research, or amusement (Brewer & Shubik (1979).

Background

- Realistic simulators are often expensive to build and maintain.
- An alternative approach is to develop a wargame for specific tasks and only include those features necessary to meet the training and educational objectives in that setting.
- Often not necessary to spend tremendous amount of money to make the wargame realistic.

Background

- Important with engaged users and that learning is integrated with the game (Garris, Ahlers & Driskell, 2002).
- SSM was developed by the Swedish National Defence College with focus on;
 - learning basic marine tactics
 - engaging/motivating to use
- This approach was evaluated.

Method - purpose

- Their purpose was to train tactics and evaluate their planning skills.
- Our purpose was to evaluate SSM as a wargame to see strengths and weaknesses (focus here).

Method

- 27 marine cadets participated in the study as part of their course in marine and amphibious warfare tactics.
- A player can take different roles, e.g. commander.
- The commander gives orders to his staff on how to move the units, use of sensors, and when weapons should be used.
- Different environments and multiple marine vessels can be adapted, e.g. boats, submarines and helicopters.

Method

- Four staffs with three SSM-clients installed in each room.
- The staffs played four scenarios, commanding blue (friendly) and red (enemies) side once each day.
- Green (civilians) and yellow (unknown) actors included.

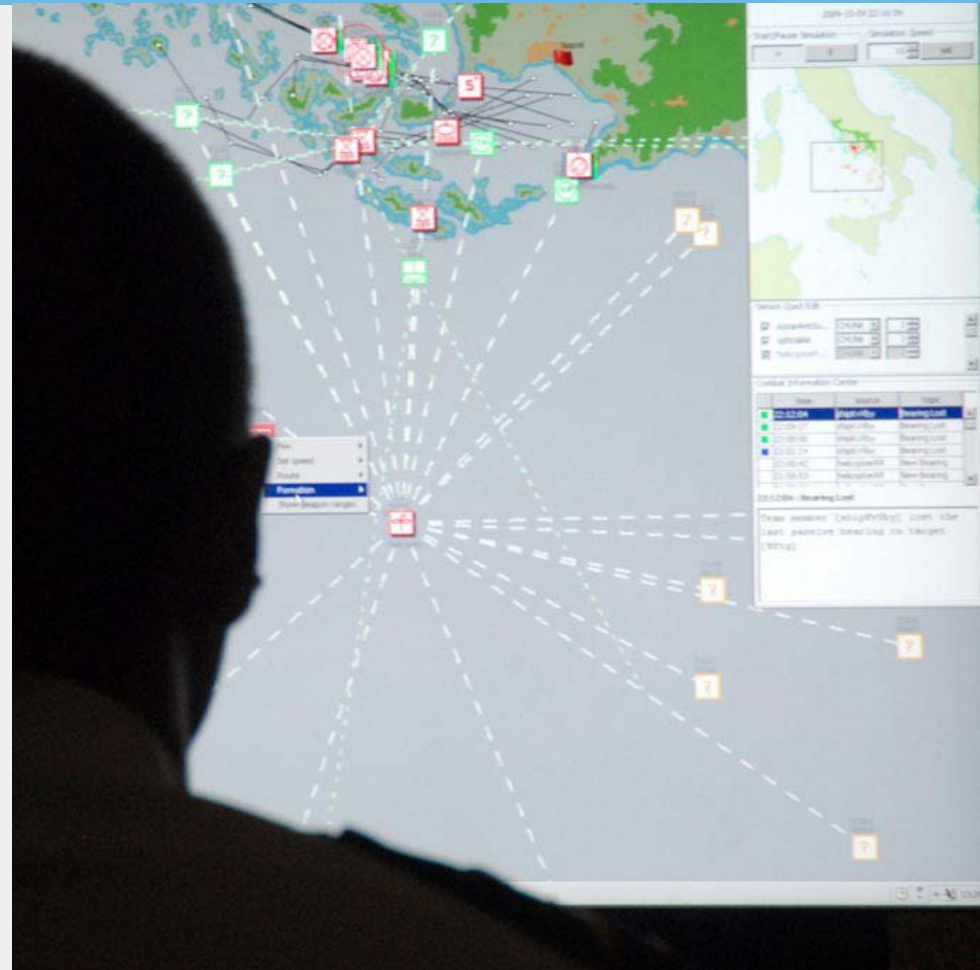


Method

- Staff A: Mission to use own forces in a tactically smart way and disembark troops in three possible harbours.
- Staff B: Defend the harbours.
- Staff C & D: Disembark & defend harbours.
- The experiment had three major phases;
 1. Each team prepared military plans (5 days).
 2. Introduction and practice with SSM (1 day).
 3. Performing the wargame with SSM (2 days).

Method - SSM

- Large map with units visualized.
- Small overall map in the upper right corner
- Function structure with information and interaction possibilities in the lower right corner.



Method – data collection

- Cadets- & instructors ratings of five concepts.
- Open questions.
- After action review.

Method – data collection

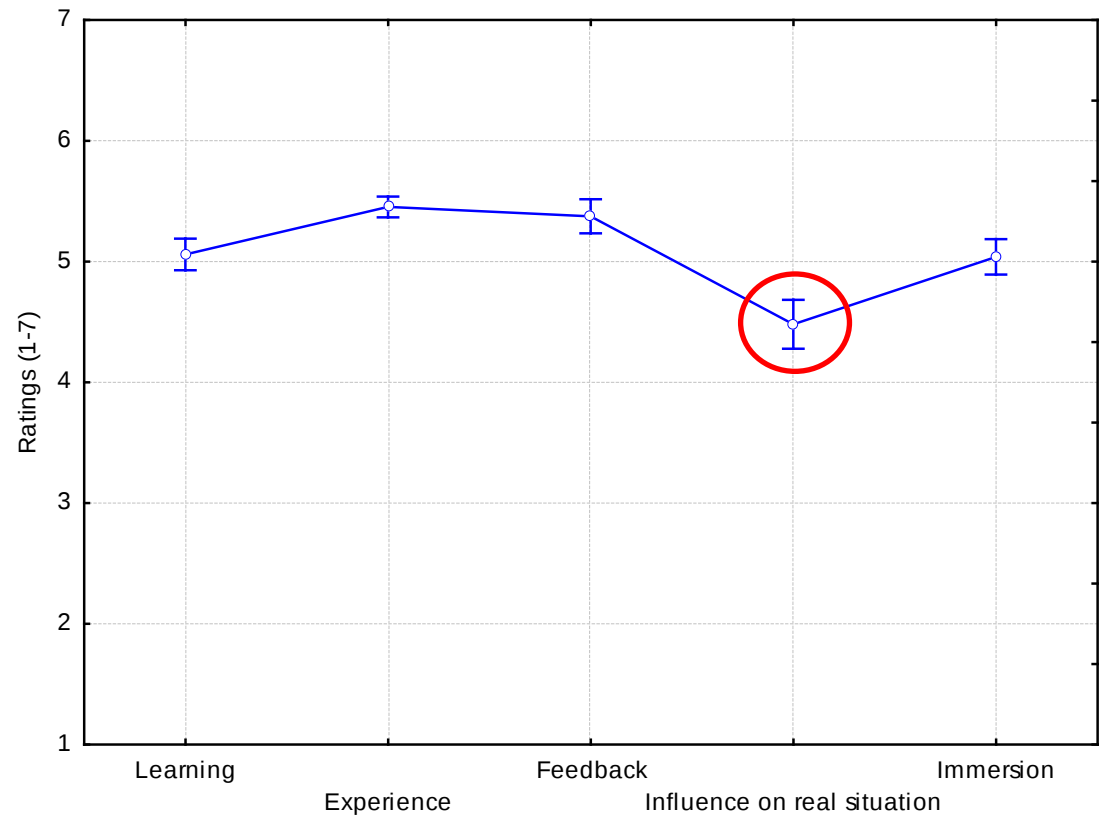
- A questionnaire was used to explore cadets and instructors experience of SSM regarding five concepts; **learning** (7 questions), **experience** (8 questions), **feedback** (4 questions), **influence on real situation** (2 questions), and **immersion** (2 questions).
- The questionnaire was developed at FOI (Nählinder, Oskarsson, Lindahl, Hedström, & Berggren, 2009; Oskarsson, 2010).
- The concepts are based on important factors that have been explored in other research (e.g. Garris, Ahlers, & Driskel, 2002; Wiese, Freeman, Salter, Stelzer, & Jackson, 2008; Witmer & Singer, 1998).

Results

- Analysis of variance to see differences between the five concepts.
- Descriptive analysis for each concept.
- Comparison between cadets- and instructors ratings regarding the concepts.
- The questionnaires open questions summarized.
- All together, these analyses and the after action review gave us a good understanding of how SSM worked.

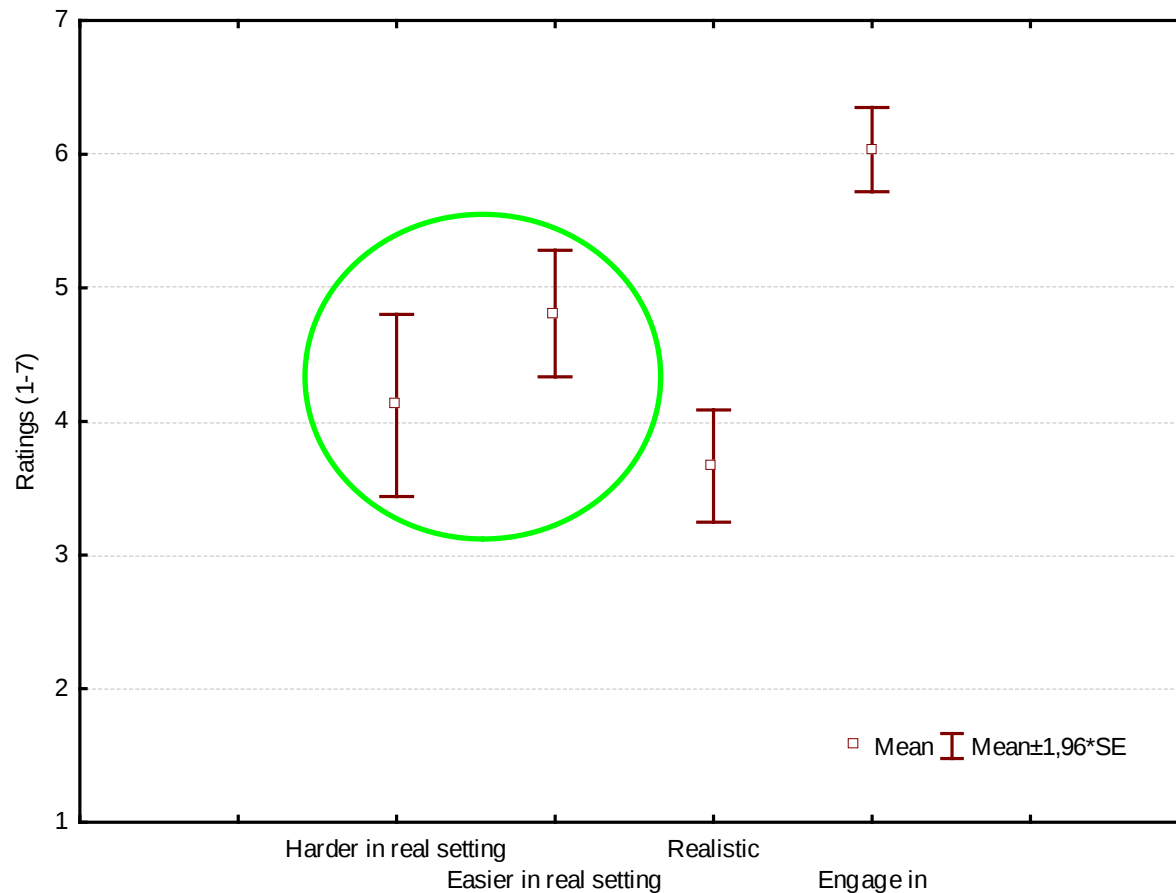
Results - concepts

- ANOVA: significant effect of concept $F(4, 100)=9.08$, $p < .001$.
- Tukey post hoc test: 'influence on real situations' was rated lower ($p < .05$) than learning, experience, feedback, and immersion.



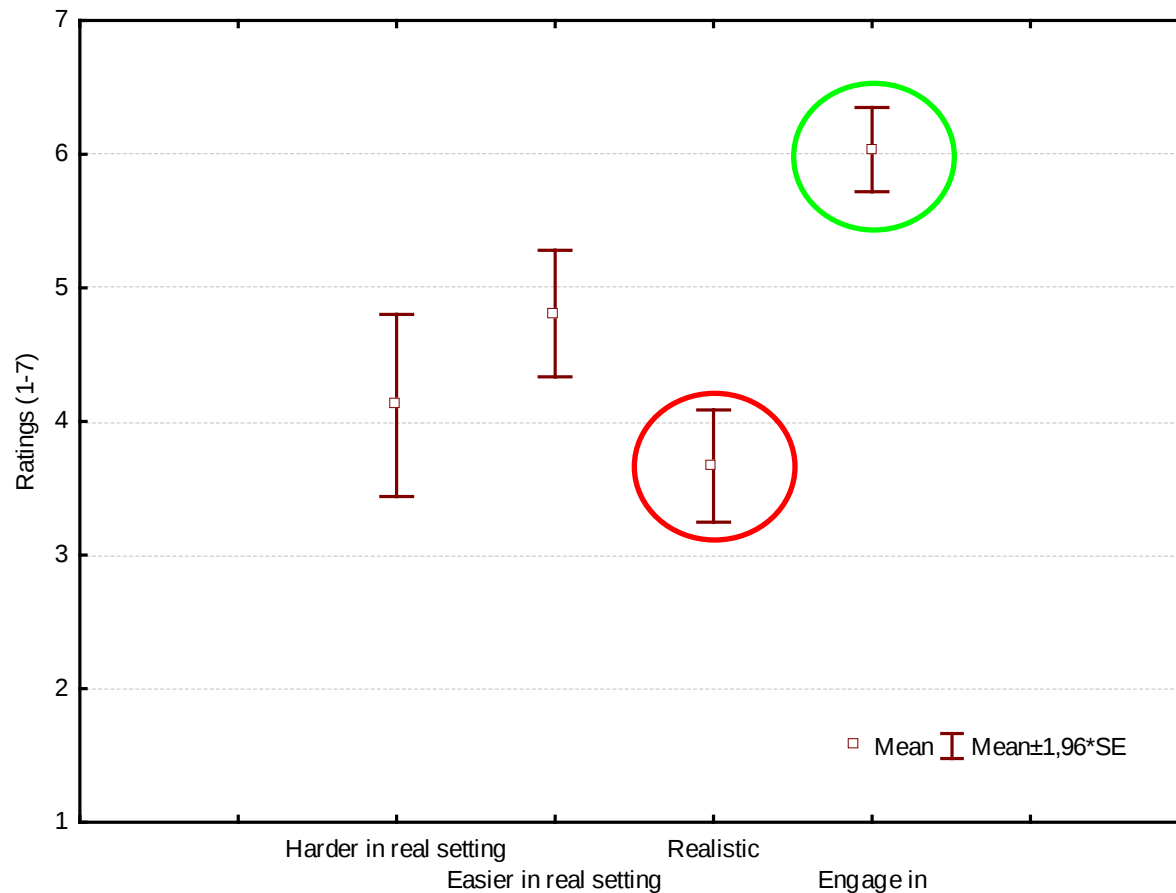
Results

Concept - influence on real situation

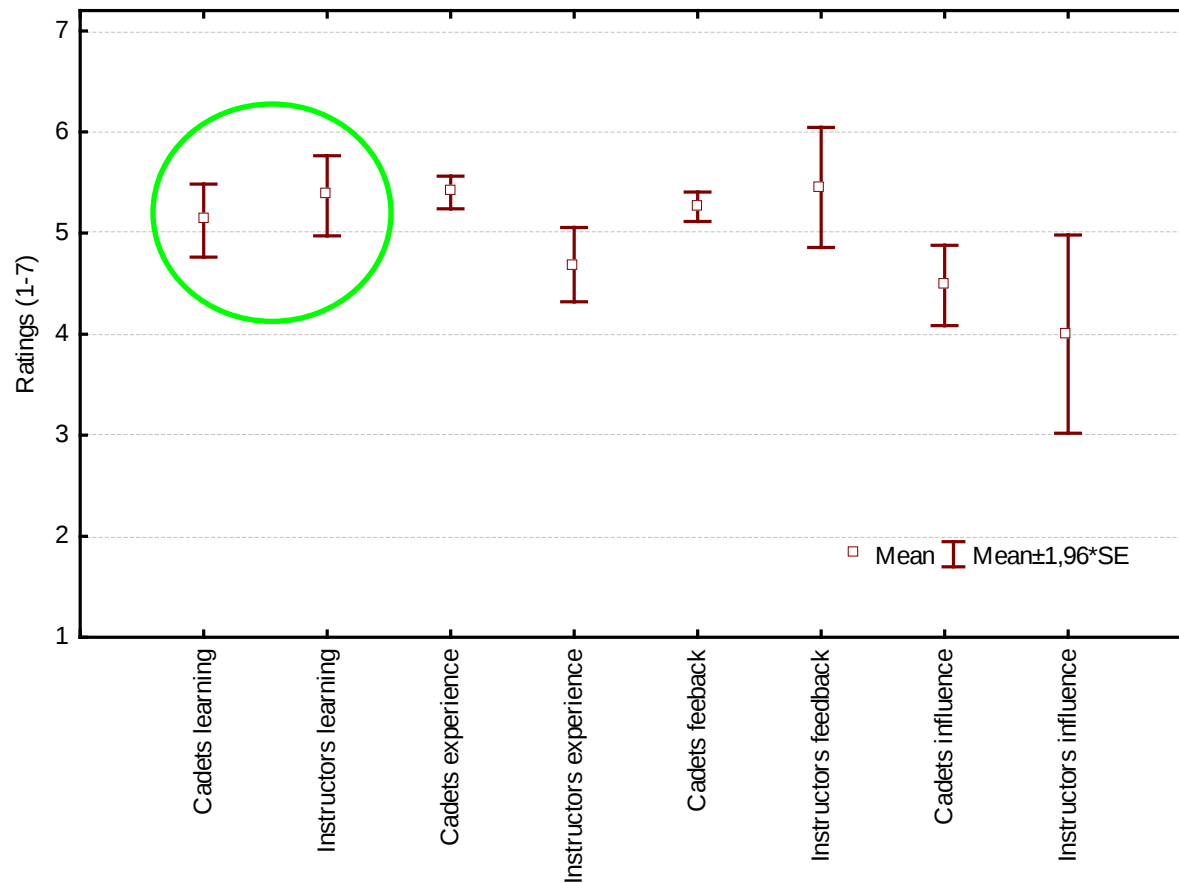


Results

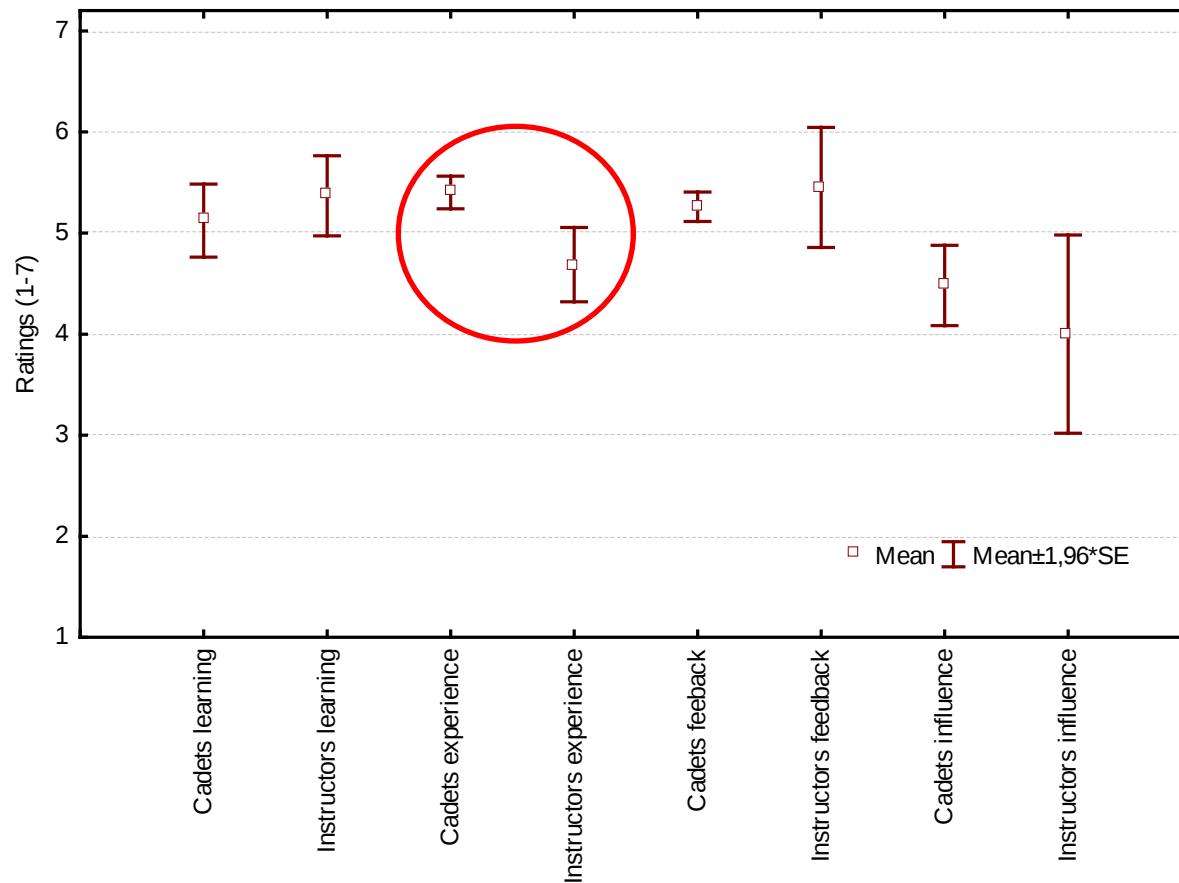
Concept - immersion



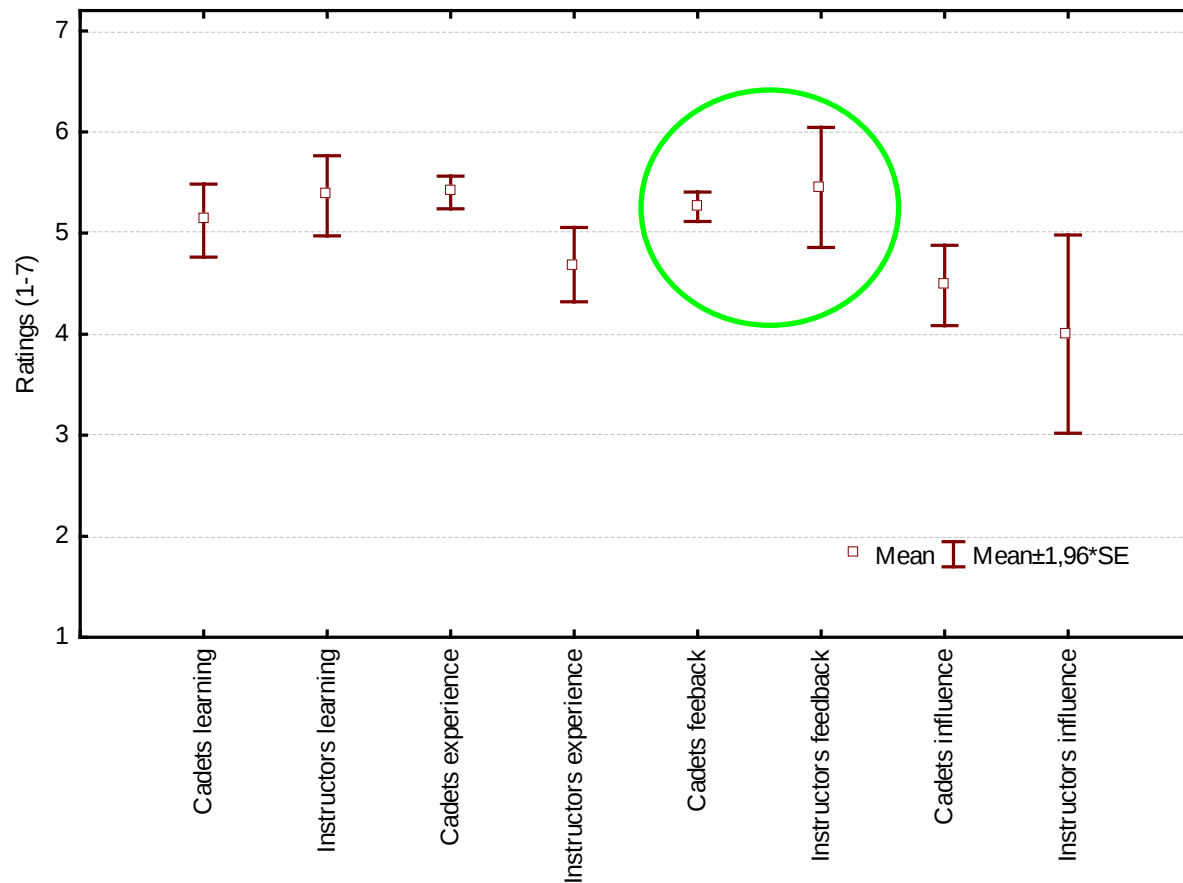
Cadets & instructors: Learning



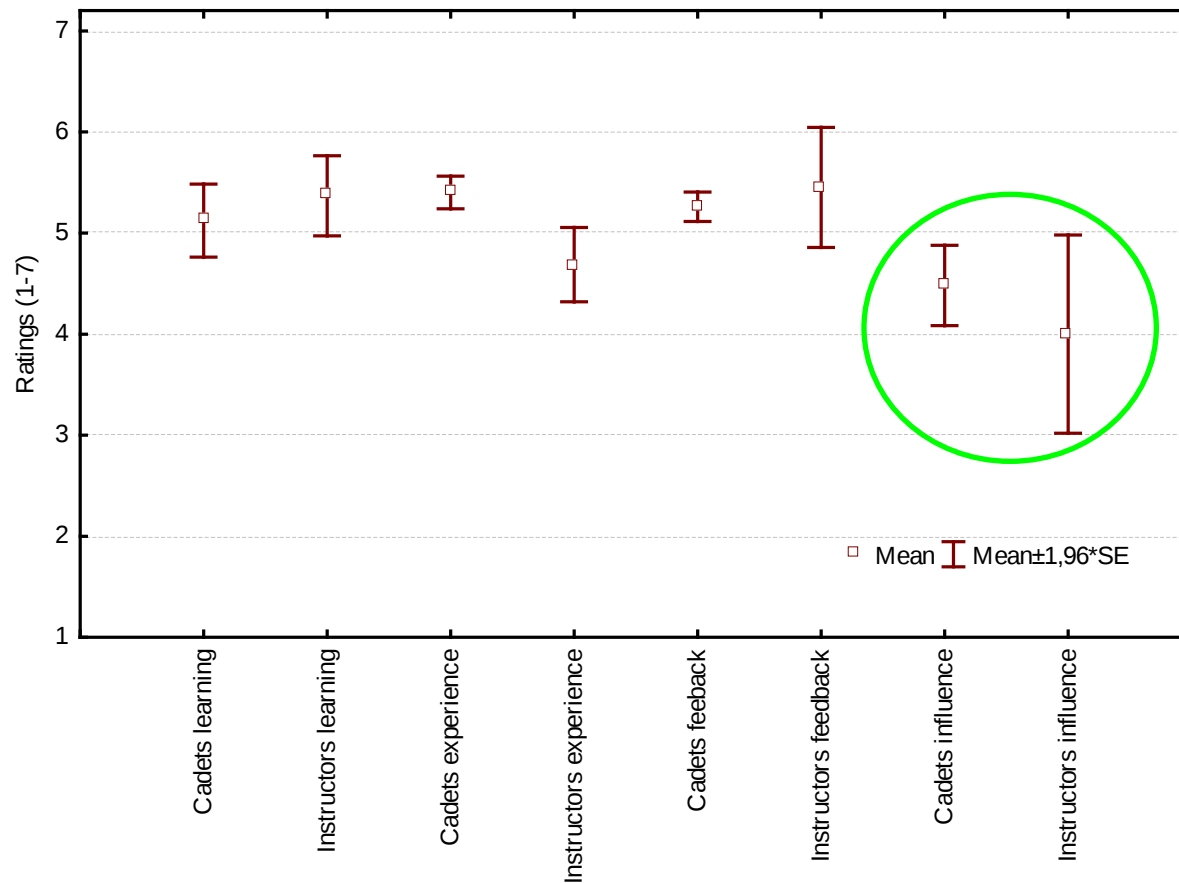
Cadets & instructors: Experience



Cadets & instructors: Feedback



Cadets & instructors: Influence on real situation



Open questions

- Does anything gets easier or harder in the real military setting by using SSM?
- Also some overall conclusions from the open questions will be presented.
- These results are summarized and are not presented in detail.

Cadets:

What gets harder after training with SSM?

- Risk for incorrect learning in the simulator;
 - Situations and abilities in SSM that does not always match the real situation.
 - Sensor and weapon abilities/algorithms do not always match the real situation.
 - Game mode: participants see the game situation as fun rather than training.
 - The complexity in SSM is not always in accordance with the real situation.

Cadets:

What gets easier after training with SSM?

- Overall better understanding of the marine military situation.
- Better understanding of marine tactics.
- Better understanding of sensors and weapon abilities.
- Improve planning skills (same process as in real setting).
- Understand the real situation better.

Instructors:

What gets harder after training with SSM?

- Ethical decisions for own-, enemy-, and neutral forces. It is easier to make a hazardous decision in a simulator.
 - However the participants have the possibility to reflect about the decisions.
- Numerous of factors and situations that is not tested, practiced, and experienced in an office setting.

Instructors:

What gets easier after training with SSM?

- The ability to take the whole situation into account.
- Decision-making, since the cadets practice this and have to make the decisions from different basic data.

Instructors:

Other comments and reflections

- Good training of decision-making since the cadets had to make decisions based on insufficient data.
- An alternative is to work and figure out more data before making decisions.
- The preparation phase making plans is of major importance to make sure the game works as intended.
- It is important with preparation for the instructors and coordination with game-command.

Discussion & summary

- The concepts show that both cadets and instructors believe that SSM can be a valuable tool in cadets' training.
- The concept 'influence on real situations' was rated significant lower than the other concepts.
 - Especially interesting since cadets have very limited experience from real military marine situations.
- The overall opinion from cadets, instructors, researchers and technical personnel was that SSM can successfully be used in this training.

Discussion & summary

- The planning phase was very important.
- All together the subjective ratings, answers from open questions, and comments during the exercise show that this, the first major wargame with SSM, was a success.
- Development of SSM to gather objective data would be desirable.
- SSM taught the cadets basic marine tactics and was engaging.