3 Skyboard

3.1 Goals of Skyboard

Skyboard is aimed at two related, but separate target groups. One target group consists of (potential) management personnel of airport based companies who are responsible for their company's change management. The other target group consists of middle management, supervisory staff and operational staff of Air Traffic Control (ATC), ground handling, airport operations and airline personnel who will face the implementation of A-CDM in the near future. These are the people who have to make decisions for their companies regarding how to deal with events in their operations, such as lost passengers, de-icing and closed runways.

The key competencies that were identified in the Training Needs Analysis included: assess; cooperate; communicate; determine correct change solution; and execute and monitor execution. Most games implicitly draw on several of these competencies simply because they are games. An example is the competency to assess. To play a game, a player needs to have an understanding of the current state of the game, but the player also needs to form ideas about anticipated changes such as those resulting from other players' moves. Examples of important indicators that need to be continuously assessed in Skyboard are the aircraft departure times and the current time, which are displayed in the form of game rounds. Each aircraft needs to leave after a designated round. A display on the board indicates which round is currently in progress. When the players do not succeed in delivering their 'services' on time, the aircraft will have a delay and will become less profitable, which is reflected in the number points the players can gain when the aircraft departs.

Since several competencies are necessary for playing any game, the development team focused on the following competencies: collaboration, effective communication, plan and execute the plan.

3.2 How to Play Skyboard

Skyboard is a board game and each player represents one of the four A-CDM roles (ground handling, airport operations, airlines or ATC). The players need to combine their efforts to turnaround several aircraft as efficiently and as safely as possible. They do this by ensuring that each aircraft receives suitcases, passengers, pilots and clearances for taxiing and take-off. The team performs best when they coordinate their moves with the other players. However, during the game, more and more problems arise at the airport frustrating the moves that players can make. Examples of these problems are sick passengers, heavy snowfall, and the breaking down of luggage belts. Each player faces many choices, such as the decision to solve a problem, to anticipate on potential problems or to quickly deliver a 'service' to an aircraft. Some of the options may seem more efficient than others, but may in fact turn out to be less efficient for the

team as a whole. The game requires constant assessment of what is best for the player and what is best for the team.

The game can be played in two modes: individual mode and A-CDM mode. In the A-CDM mode, the players play together to achieve the highest possible team score. The individual mode is the reference which is comparable to the common way of operating. In the individual mode a team score is also calculated, but all players play individually trying to maximize their own scores. This way, trainees should experience that their combined performance (number of aircraft departing on time) is better when they cooperate compared to when they play individually.

3.3 Instructional Guidance

Learning is facilitated when the learning materials are elaborated on and have become meaningful to students [10]. Simply learning is not sufficient. For a training to be effective, trainees need to link what they have learned to their daily life (transfer of training). Instructor-led reflection aids students in separating main ideas from game details and helps them to create links between game and practice [11]. An educational guide accompanies Skyboard to aid instructors in identifying signal behaviours. It contains several observational checklists which aid the instructor to identify effective trainee behaviours and which competency they pertain to. Examples for the competency effective communication is to ask questions, share information and use verbal and non-verbal communication. The instructor makes notes of these behaviours and interrupts the game to provide feedback when the trainees encounter a problem, such as when they notice they cannot get an aircraft to depart on time, when they get frustrated, when they are happy that they have achieved something, etc. The group elaborates on and discusses what happened, what caused it to happen and how they can prevent the event from happening in the future. Interrupting the game creates the opportunity for trainees to immediately practice what was learned.

4 Results of Testing Sessions

The test sessions during the first development cycles took place within the development team, with gaming and training experts at the Dutch National Aerospace Laboratory – NLR and with training experts at Trinity College Dublin. Three sessions were held at a large European airport with representatives of the target group. The results from each session were used as input for further development of the game.

4.1 First Test Session

The first of these sessions was intended to test the concept of serious games and to generate ideas for further development. An early prototype of the game was played and commented on by airport staff. This session focused on game dynamics and on how representatives of the target group considered serious games.

The trainees were very enthusiastic about using a serious game to aid the introduction of A-CDM. They were positive about physically meeting other representatives of airport companies, instead of only talking on the phone or emailing. However, the game dynamics were not good enough yet. The game did invite trainees to discuss A-CDM related issues with other trainees, but it did not immediately invite to cooperate. Therefore, the game development after this session focused on developing game dynamics that force trainees to cooperate. A game dynamic that changed after this session was, for example, the introduction of barriers that make it harder for players to achieve their goals.

4.2 Second Test Session

The target group of the second session consisted of change managers. The goals of this session were to verify how the trainees appreciated the improvements that were made to the game and to explore what the trainees learned by playing the game.

This session firstly explored the attitudes of participants towards the introduction of A-CDM. All participants looked forward to it, expected it to improve coordination, and expected it to increase predictability of arrival and departure times.

The second research question pertained to the belief of participants that serious games can effectively contribute to learning. Trainees were asked to rate several learning environments in their suitability for training skills. After playing the game, the trainees were more convinced of the effectiveness of serious games compared to their initial attitude towards serious games before playing the game.

Thirdly, trainees were asked which learning goals they thought the game would achieve. Most of them indicated that the main learning goal is in the area of collaboration.

A final research question was to find out how much players enjoyed playing Skyboard. This is an important question, because students who enjoy a learning experience are more motivated to perform their best [12] and will therefore learn more from their experience [13]. The participants indicated that they enjoyed playing the game. Figure 1 shows the attitudes of players regarding Skyboard. Players were satisfied with most aspects of the game, but somewhat less positive on learning how to play the game.

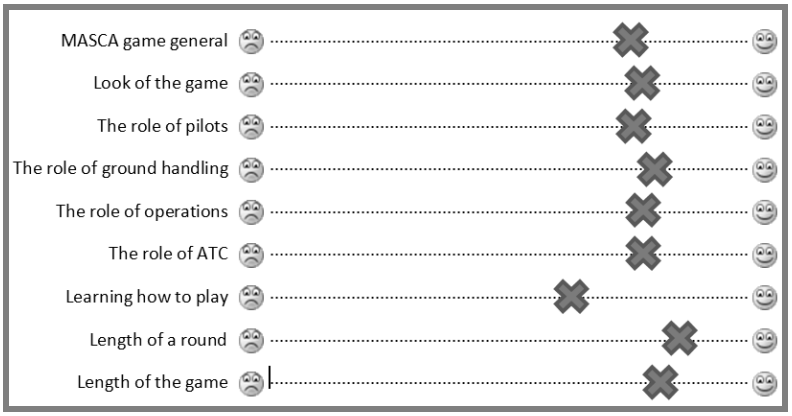

Figure 1. Target group attitudes towards Skyboard

4.3 Final Test Session

The last session was performed with the same target group as the second session and it mostly studied the same questions, but it was performed with other stakeholders from the airport. An additional goal of this session was to study if the game required further improvements or if it was ready for finalization and validation. The validation will study if the game indeed achieves what it was intended to achieve.

The results are mostly comparable to the second test session. All participants looked forward to having A-CDM introduced at their airport. They expect better predictability and more accurate information on arrival and departure times. The participants' beliefs towards the effectiveness did not change after playing Skyboard, but were quite positive (7 positive against 1 negative) beforehand. The learning goals that they expected were a better understanding of A-CDM and were in the area of cooperation.

An important finding from this session was that there were no significant differences in the appreciation of Skyboard ($F = .192$; $p = .977$). Thus, the participants in the final test session were comparably satisfied with the game, indicating that further improvements on game dynamics were no longer necessary and the game was ready for validation.

5 Preliminary Results from Validation

The validation has started, but the results have not been analysed yet. They are expected in the beginning of August. This chapter will give an overview of the method of validation and preliminary results.

5.1 Validation Set-up

A total of 40 students were recruited for the validation. One no-show resulted in the cancellation of one group of four students. Each validation session lasted approximately 2 hours. Students were randomly assigned to the experimental condition groups (CDM mode) or to the control condition groups (individual mode). The sessions started with an instruction and group discussion about the turnaround process to get the students acquainted with the domain. Next, the experiment leader briefed participants on Skyboard's game rules followed by playing the game in CDM mode or in individual mode in groups of four students each. After playing the game, the participants were presented with an 'Einstein's Riddle', a riddle that requires deductive reasoning to solve. Participants were instructed that they could work together, but they were not obliged. Finally, the participants filled out an enjoyment questionnaire and a cognitive workload measurement.

During gameplay and solving the Einstein's riddle images and sounds were recorded with a video camera. The experiment leader acted as instructor. To ensure that all groups received approximately the same amount of instruction at the same times the instructional guidelines were slightly altered. Instead of interrupting the game for discussion on observing signal behaviours the game leader gave feedback on the students' behaviours after each three rounds (e.g. after round 3, 6, ,9 and 12).

Observational checklists were used to investigate if the game trains the competencies: collaborate, effectively communicate and plan and execute the plan. Video playback was used to tick off the behaviours relating to these competencies during every three rounds played in A-CDM mode, resulting in four measurements (first quarter: rounds 1-3; second quarter: rounds 4-6; third quarter: rounds 7-9; and fourth quarter: rounds 10-12).

Observational checklists were also used during Einstein's riddle to assess if a difference in behaviour was observable after playing the A-CDM mode compared to playing the individual mode (non A-CDM mode). Behaviour was identified as being good if people communicated and tried to cooperate during the riddle and behaviour was identified as bad when people did not communicate during the riddle or showed insufficient cooperation. All behaviours were rated on a four-point frequency scale based on the observational rating scale [14] and could take the frequencies: rarely, sometimes, regularly, and consistently.

Furthermore, a questionnaire was handed out both before and after playing the game to measure the tendency to cooperate. This questionnaire measured whether people enjoy working in a team and if they thought their performance would improve in a team compared to working individually.

The topic of enjoyment was measured using a scale based on an existing measurement scale for measuring players' enjoyment of games [15]. This scale was originally intended for video games and was adapted to fit a board game. The questions pertained to concentration levels during the game, the clarity of the goals, the amount and level of feedback, the level of challenge, the level of autonomy, the amount of skill improvement, and the overall enjoyment of the training.

5.2 Preliminary Results

Preliminary results indicate that each competency improves while playing the game. These results were gathered by observing the students' behaviours during the first, second, third and fourth quarter of the game. Thus, the behaviours relating to the competencies collaborate, communicate and plan and execute plan appear to be used more often as the game progresses. However, the observable behaviours during Einstein's riddle do not appear to differ between the experimental and control groups.

Furthermore, the difference between the experimental and control groups on attitude towards teamwork do not seem to differ pre-test or post-test. There does appear to be an interaction indicating that the experimental group's attitudes increased more than the control group's attitudes.

The enjoyment questionnaire indicates that both the experimental and the control group enjoyed playing the game. The enjoyment levels do not appear to differ much between both groups.

5.3 Discussion

Skyboard appears to yield positive results regarding training the selected competencies. However, even if the definitive results show that the use of the behaviours related to these competencies increases significantly, they need to be critically evaluated. Only one observer rated the behaviours. The observer was not blind to the conditions (e.g. the rounds the games were in). An observer needs to see what happens on the board to be able to interpret what the players are doing. Therefore, s/he should be able to view the board as well as the players. However, the board shows the game state and it is not difficult to estimate what quarter of the game (first, second, third or fourth) the observer is seeing. This makes it very hard if not impossible to have a blind observer.

Einstein's riddle does not appear to yield differences between the experimental and the control group in observable behaviours. This can be due to the way the measurements were taken. Negative behaviours were counted and subtracted from the number of positive behaviours. However, the observable behaviours in Einstein's riddle were not rated on efficiency. Therefore, an efficient group could show one very positive and efficient way of cooperating, such as dividing the tasks. This would result in only one point. Another group that discusses the problem and shows more, but less efficient, cooperative behaviour would score more points, but may perform worse. This was not observable on the task itself as none of the groups managed to solve the riddle.

A result that was not anticipated is that the game seems to take up an equal amount of time for both groups. Earlier sessions showed that the CDM mode took players longer than the individual mode. A more thorough analysis should be performed to find out if the required time differs significantly or not. If the CDM mode indeed takes up more time there is a cost to working together, but if CDM mode it does differ it may only lead to better outcomes without additional costs in time.

In summary, the game does seem to contribute to learning, but the analysis still needs to be executed to find significant differences.

6 Future expectations for Skyboard

6.1 Exploitation of the Game

The intended target groups of the game are people working on airports who are in the process of changing towards A-CDM. The game has been introduced at an airport and will be part of a dispatcher training in September 2013. Other airports may benefit from using the game as well, because it can aid in the training of competencies that are important for A-CDM. Other people who require the competencies collaborate, communicate, and plan and execute plan may also benefit from playing Skyboard, such as change managers who work at airports.

The game dynamics have been set and balanced and can also be translated into other domains. The domain model of the game can be altered to facilitate transfer of training from the training situation to real life. This is done by removing domain aspects, such as the airport, aircraft and roles and replacing them with aspects of the new domain, such as a fire station with fire trucks and roles that are important for the new domain.

6.2 Future Research Paths

Future research should focus on the efficiency of the game and should result in behaviours that can be identified by a blind observer. Also, after playing the game, the changes in behaviour should be studied. This should include not only the frequency of behaviours, but also the quality of these behaviours in terms of efficiency.

Furthermore, the transfer of training from the training situation into real life should be further investigated to show that the game does not only yield results in situations comparable to the training, but also in the work situation of the players. This is also why the game has been tested on a large airfield.

The game in itself is not a full A-CDM training. It aims at creating more positive attitudes towards CDM and at training competencies required for dealing with the introduction of CDM. A full CDM training also includes topics that are aimed towards the knowledge side, such as how to use Departure Planning Information messages (DPIs). However, the validation will prove if the game can make a solid contribution to A-CDM training.

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