Collaborative Learning & Serious Game Development

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Abstract

This paper presents the overall Learning, Training and Mentoring (LTM) Framework as developed as part of the MASCA project. They key focus of the LTM is on the establishment of a collaborative learning framework and integrated learning package that focuses on supporting continuous performance improvement and learning framework (competence and capability at all levels) and ensuring this overall learning is fully aligned to the overall strategic blueprint of the organization. One of the key outputs of the LTM was the development of a Serious Game called Skyboard. Based upon a training needs analysis and an iterative development, implementation approach in one company, the research found that SKYBOARD was an effective means of enhancing communication, collaboration and decision making across intra-organizational agencies who had to collaborate in order to implement a cross-agency change initiative.

Keywords- MASCA, Collaborative Learning, Serious Games, Skyboard

I. INTRODUCTION

Traditionally the concept of 'learning' has been related to formal education, whereas its use in the context of work is a relatively new phenomenon. Interest in workplace learning has expanded since the beginning of the 1990s, and currently the research in this area is both wide-ranging and interdisciplinary. The reason for this expansion is the unprecedented rapid change in society and working life that has taken place during the past few decades. The rapid development of information and communications technology, the growing production of knowledge in the economy, increasing internationalization and globalization as well as changes in occupational structures. The contents and organisation of work have challenged not only educational institutions but also work organisations to develop new ways of ensuring that the level of competence and capability of the workforce meets these challenges [1]. Thus, continuous and collaborative learning has become important both for individuals operating in the learning society and for organizations competing in international markets.

However many organizations are still focusing on the traditional approach to training. Figure 1 outlines 5 stages of work-place learning from stage 1 traditional classroom training right through to stage 5 more collaborative based training. The emerging evidence suggests that while many organizations are highlighting that they are not getting the value from stages 2-3, this is still where the majority of training activities are focused. Hart 2012 [2] found in her research that only 14% believe that the traditional approach to company training is an essential way for them to learn in the workplace.

For example in the Aviation sector, Human Factors training was recommended for all in the organisation from operational staff to senior management. The International Civil aviation Organisation (ICAO) mandated Human Factors Training for various categories of aviation professionals. The European Aviation Safety Agency (EASA) also has requirements on Human Factors training. Furthermore the International Air Transport Association (IATA) requires Human Factors training through the two standards IATA Operational Safety Audit (IOSA) and IATA Safety Audit for Ground Operations

(ISAGO). All the above requirements and standards resulted in huge volume of Human Factors training offered to staff of Airlines, Aviation Maintenance Organisations, Airport Operators, Airport Handling Companies and Air Traffic Services.

But 10 years on – does this approach to training (again primarily falling between stages 1-3 as identifed in figure 1) actually result in improved performance and enhanced capability in the workplace? Research from previous EU funded projects [3,4,5] highlighted that during the Human Factors training programmes, frustrations were often expressed by staff that they were trying their best in applying the new learning but the system did not support them . Training was criticised by staff as being 'idealistic' and 'removed from the realities of the system'

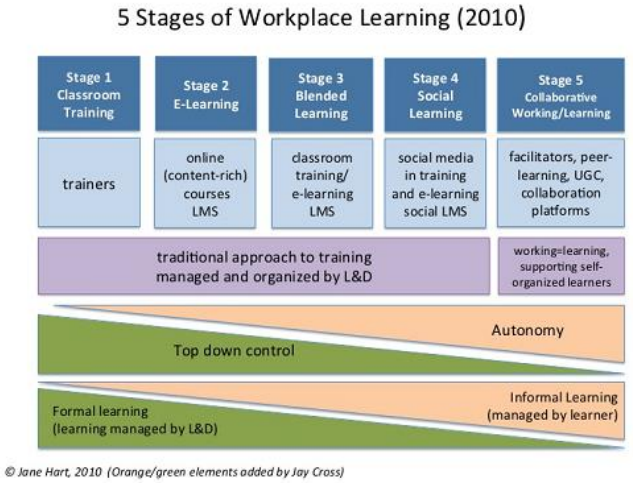

Figure 1 5 Stages of Work-Place Learning

Return of Investment was also reported as having been difficult to demonstrate in terms of Human Factors training. Anecdotal evidence from aviation organizations suggests that they find formal training approaches "costly, repetitive, inconsistent and largely unmeasured" and they struggle to quantify the real value (increased safety and improved performance to ensure competiveness) to their operations in the ongoing investment in their training initiatives.

There is also evidence to suggest that as much as 60 to 80 percent of the 'learning' that occurs in today's workplaces arises from the more informal, tacit and social systems of knowledge exchange and from what actually happens in normal operational practice[3,5,6].

In order to successfully optimize the way this learning is developed and existing knowledge and experience is exploited, organizations need to facilitate the dynamic capabilities required for converting the knowledge available from the insights and competences of people into appropriate structures, processes, products and systems that allow the value to be exploited. Therefore what is needed is a more flexible, operationally embedded deployment of ongoing collaboration and learning opportunities within the air transport system– 'the right level of knowledge, to the right people at the right time'. Furthermore the knowledge and skill has to be based on a new understanding of how the complex system-of-systems of aviation works, how it should be managed, how it can be changed and how to design for improved future system operations [7].

The overall objectives of this paper is to provide an overview of the MASCA Learning, Training and Mentoring (LTM) framework, focusing on the development, implementation and evaluation of a Serious Game to support learning and collaboration in one organization's change management program.

II MASCA APPOACH TO COLLABORATIVE LEARNING

The overall MASCA work program has a primary focus on the transfer of change management capability into the organizations that are responsible for and involved in change. In order to effectively support the change initiatives a core component of the MASCA Change Management System is a framework for Learning, Training and Mentoring (LTM). The underlying principles of the MASCA Learning Model is based on an on-going and collaborative learning process, with each phase involving preparation and guidance, collaborative learning, consolidation of that learning and practically focused next steps.

The key supporting infrastructure within the MASCA learning framework is the establishment of a collaborative and flexible (i.e., on-line) 'meeting place' that enables a community of users to collaborate in building and learning an archive of practical knowledge that will continually capture the overall learning processes, lessons learned, the requirements of key skills and knowledge into a flexible and interactive resource that can be utilised by all stakeholders. Figure 2 provides an overview of the key features of this integrated and collaborative learning community.

Figure 2 Overview of Key features of MASCA Learning Framework

This proposed approach to learning is multi-layered and multi-faceted. In its broadest sense it is a continuum of approaches in terms of time, place, pace, content and mode of learning applied in varying degrees. Its overarching purpose is to increase opportunities and options available to learners and give them greater control over their learning through an integrated package of learning modes and interactions. This includes the capacity for high level strategic competence and capability through participation in a Master's Program. One of the key outputs of the MASCA project was the development of a Master's Program. 'Managing Risk and System Change' due to commence in September 2014. The framework also includes the design and delivery of highly participative training programmes (both on-line and face-to-face). The training programs developed have provided practical tools & guides, personal development opportunities practices dealing with 'real' implementation issues & providing the participants knowledge, skills and attitudes to 'practice' in a safe environment.

As one of the key aspects of the framework focused on the establishment of a learning community the active use of social media (e..g, on-line discussion groups) and on-line collaborative learning tools (e.g., webinars) was also utilized as part of this overall learning framework. The development of a Serious Game was one of the innovative outputs of the project and the following section provides an overview of the development process, implementation and evaluation of the SKYBOARD Serious Game and how it supported the implementation of change in one organization.

III SERIOUS GAMES AS AN EFFECTIVE MEANS TO MEET LEARNING NEEDS

To support the MASCA learning and training framework, a serious game called Skyboard was developed within the MASCA programme. "Serious Games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement." [8] They are games that aim to teach the players competencies that are important and relevant for their professional development. Serious Games are often used in parallel with other learning tools and environments, such as lectures, e-learning forums, and simulators.

The advantage of using serious games over other learning tools is that serious games enhance students' motivation [9]. In fact the games elicits them to play, and therefore learn, over and over again [9]. A serious game is considered well-developed when the correct balance between entertainment and education is found. Therefore, the development of a serious game is a flexible process with many iterations and interactions between developers and potential users to ensure the correct balance and continuous and on-going learning.

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II. METHODOLOGY

The development process of serious games is iterative in nature and visualised in figure 3.

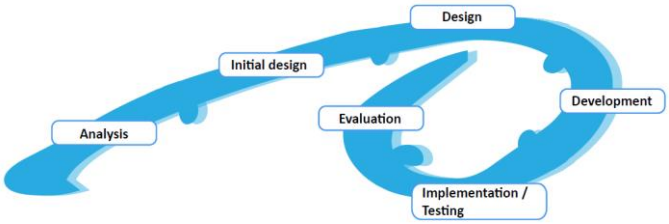

Figure 3 Development process of MASCA game

The development process starts with gathering information necessary for the initial design. Most of this information results from a training needs analysis (TNA), such as the composition of the target population, the available play time and the competences that need to be trained. The rest of the required information comes from the user requirements analysis. This information answers questions regarding four entities: the knowledge domain, the game principles, the simulation model and the didactical principles. The target audience of Skyboard consists of people working at airports in middle or higher management. These are the people who have to make decisions for their company with regard to dealing with events in their operations, such as lost passengers, de-icing and closed runways.

Based upon the TNA a competency profile was developed, with the key competencies including creating a common

understanding of the mutual benefits of implementing A-CDM, communication, joint decision making and information sharing. For the complete profile of Skyboard the reader is referred to Zon and colleagues [10]. After that the transfer from competency profile to game mechanics is made. Game mechanics form the framework of the game, and comprise the way how players interact with the game. Examples of game mechanics are the pieces that chess players use to express their moves on the board to the other player, or rolling a dice to determine the likelihood that something happens during game play.

In order to design a serious game each competency from the competency profile will be linked with one or more game mechanics. Some game mechanics can cover multiple competencies, therefore competencies that are similar or fit into the same mechanics can be chunked. These links ensure that the players will be rewarded for demonstrating the behaviour that matches with the competency profile and 'punishes' non-compliant behaviour.

The next design step is balancing and test-playing the game with a prototype. It is not easy to predict whether particular strategies of playing the game willalways lead to winning, nor that playing according to the competency, that the game is supposed to teach, is more rewarding. An automated procedure based upon a computer model of the game was developed for parts of the balancing work. However, test play is still needed, to compare the computer model with the creative behaviour of real human players.

III. PLAYING SKYBOARD

Skyboard is a board game that is played by 4 persons. Each representing a stakeholder in the A-CDM process: ATC, Airline, Ground Handler and Airport.

The aim of the game is to make as many aircraft as possible depart on their scheduled departing time, while at random various bottlenecks (like missing passengers, snow on the runways, etc.) emerge while playing the game that interfere and disrupt the schedule of ensuring that as many aircraft departon time.

The game may be played in two different modes. In the A-CDM mode players are rewarded and elicited to collaborate and play as they would in an airport where all stakeholders are fully operating according to the A-CDM principles. In the non-A-CDM mode players are encouraged to work as they normally do without a strong necessity to collaborate or work according to A-CDM principles. Based upon the scores that players will accomplish when playing the game and based upon the feedback that players will receive from the trainer the difference between A-CDM and non-A-CDM will become unmistakably clear to all players.

The game board (see figure 4) can be seen as a shared Situational Awareness between the players. The board is a bird's eye view over the airport. All aircraft standing at the gate, all bottlenecks that need to be solved and the status of every player can be seen. All players are able to see for themselves what the situation at the airport is, where help is needed, where deviations from the planning are taking place. They can decide for themselves whether they should take action and support the other stakeholders or not based upon this knowledge.

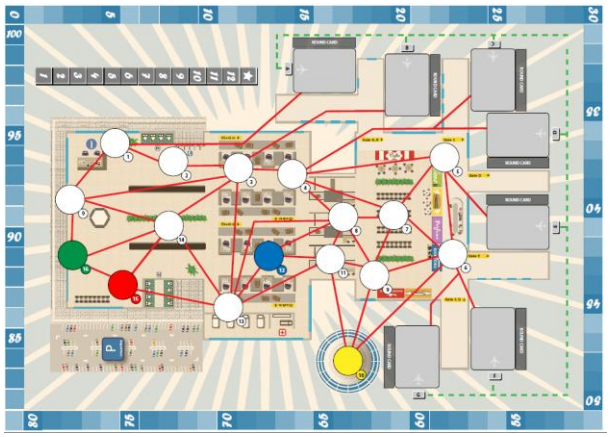

Figure 4. The gameboard.

While playing the trainer will provide feedback to the players upon their behaviour, thereby enabling them to adjust their behavior and experiment with the effect that other behaviour may have.

IV. EVALUATIONS FROM DEVELOPMENT WORK-SHOPS

The first 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 more elaborate test sessions /workshops were held at the airport with representatives of the target group. The following paragraphs present these test sessions and the results they have generated.

Each session was preceded by a presentation of the role of the game in the process of introduction of A-CDM and test play to familiarise the players with the new game.

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 stakeholders, 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.

Second Test Session

The target group of the second session consisted of change managers from the same aiport. 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 started with exploring the attitudes of participants towards the introduction of A-CDM. Even though the expectation was that some participants would still be a little unsure of the implementation of A- CDM at the airport all participants indicated that they were looking forward to it. Their expectations for CDM were that it will contribute to a better coordination and better 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 on 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 (as stated above) who enjoy a learning experience are more motivated to perform their best and will therefore learn more from their experience. The participants indicated that they enjoyed playing the game. Figure 5 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 complex game.

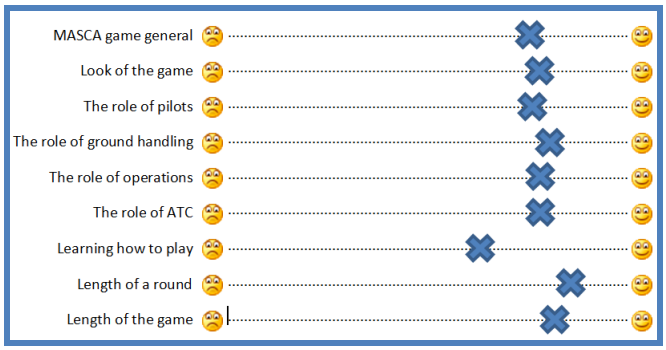

Figure 5. Target group attitudes towards Skyboard

Third Test Session

The third 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 finalisation and validation.

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.

V. CONCLUSIONS

While the fun element is a key aspect of the Serious Game development, this study and other studies have shown that Serious Games do play a role in fostering the development and improvement of various soft skills, like communication, collaboration or negotiation and to enhance overall collaborative learning [11, 12]. The key benefits of introducing the Serious Game to support the implementation of A-CDM in this case included the opportunity for the key stakeholders to spend significant time with each other, getting to know each other in a fairly relaxed and 'fun' environment and getting a better understanding of each other's roles and the challenges they were facing with the implementation of A-

CDM. A second benefit of the game was that it raised more awareness and initiated a more in-depth discussion of the implementation of A-CDM and what it meant for each of the stakeholders. The next phase of the overall approach within the airport is to more fully embed the Serious Game into a more specific training program for the key operational staff.Collaborative learning is an approach based on the idea that learning is largely a social behavior involving groups of learners working together as a team to find a solution and work together in implementing that solution. Collaboration is broadly defined as interaction among two or more individuals and can encompass a variety of behaviours including communication, information sharing, co-operation, co-ordination, problem solving and negotiation in order to create an overall common and compatible operational picture. One of the most important elements of learning which is absent from traditional approaches to training and learning is the process of social interaction in order to establish an understanding of this common and compatible process and the content of knowledge, competence and capability to achieve the overall strategic plan for change. This level of understanding and learning is vital for the success on implementing A-CDM and ensure on-going learning.

Organizational learning is complex because there are several different types of change agent and different knowledge cycles. Change agents develop competence to lead, manage and participate in change to fulfil strategic goals. Their efforts and involvement creates momentum in the change process. They include the leadership of change, internal specialists, external experts, middle management and all the participants in the change program whose activity makes it work. Middle management has a critical role in change management as a conduit of information – both formal and informal, both up and down the management hierarchy and sideways across departmental and organisational boundaries. The technical competence that such managers necessarily have needs to be complemented by soft management skills and social and emotional intelligence, to enable their role in facilitating change.

The relationship between internal and external change agents was an emerging area of interest in the MASCA project interesting. External experts provide the opportunity to consider ideas that are beyond the scope of the normal focus of management (longer timescale, wider horizons) – they provide the opportunity to explore such ideas without necessarily committing to them, and if they do not appear to work they can be discarded, along with the external expert! Thus they provide thinking space, outside normal constraints, but it is the role of the internal change agents to bring this thinking back to meet the internal demands of what will work within the organisation and its operations. External agencies can include research consortia, communities of practice, consultancy amongst others. In many cases this external role is not sufficient to transfer a high-level strategic change competence into the organisation. Thus internal change managers and other specialists within the organisation need a process for their own competence development through advanced learning, for example in a Master's program.

This is a longer-term trajectory of capability building, but can overlap with specific change initiatives. The overall MASCA learning framework (figure 2 above) highlights the pivotal role of a learning community that includes both internal and external agents of change and the transfer of knowledge across various collaborative based activities (e.g., Master's Program, Serious Games, webinars etc).

It is becoming apparent that we are at the beginning of a fundamental shift in the way that both learning and working is happening in organisations. Therefore the establishment of a collaborative learning framework and integrated learning package needs to focus on supporting continuous performance improvement and learning (competence and capability at all levels) and to ensure this overall learning is fully aligned to the overall strategic blueprint of the organization.

A key aspect of this framework is that it requires persuading organizations to this new way of learning. This means recognizing it is no longer just about using traditional "command and control" approaches (that are employed in most training solutions to try and force people to learn), but will also involve encouraging and supporting people to engage in new collaborative activities to support one another as they work by helping them to "connect and collaborate".
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VI. ACKNOWLEDGEMENT

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