The active instructor: Benefits and barriers to instructor-led serious gaming

Anna-Sofia Alklind Taylor
School of Informatics
University of Skövde
Skövde, Sweden
Email: anna-sofia.alklind.taylor@his.se
Telephone: +46 500–448331

***Abstract*—While there is a wealth of studies on the subject of serious games, the same cannot be said on the issue of teaching with games, especially in game-based learning settings with adult learners. Over the years, most research in this area has been focused on the 'active substance(s)' of games for learning, focusing mainly on characteristics of games, but often failing to take the whole context of game-based learning into consideration, such as the role(s) of the teacher. However, the past two or three years has seen a shift in focus from merely the game as an isolated artefact, to also include more discussions on how games can successfully be integrated into an educational setting, as well as challenges as pitfalls of which instructors need to be aware. This paper aims to outline the contemporary research on instructor-led serious gaming and its implications for the design of serious gaming environments.**

Keywords*—*Serious games; Game-based learning; Instructor-led serious gaming; Instructors; Facilitators

I. Introduction

What constitutes 'good' practice in serious gaming? As the field is moving towards maturity, scholars have only recently begun to look at the needs and obstacles that instructors face when using games for non-entertainment purposes. This paper explores the use of serious games from an instructor perspective. More specifically, it aims to describe the roles of instructors and the benefits and barriers to instructor-led game-based learning environments. Research within the field of serious games has mostly focused on the learners' perspective, but little attention has been paid to what the instructors do and what challenges that entails.

Computer-aided and game-based instruction was initially seen as something that would, to a degree, replace teachers. For instance, in the 1970's, games were predicted to act as coaches or tutors in the future [1] and there are still efforts in creating algorithms that will perform certain task that are now performed by a human instructor (e.g. [2]–[5]). However, more and more scholars are starting to realise that serious games, as artefacts used for learning and training, cannot fully replace the instructors' tasks, but must rather be designed to support them. Thus, instructors form an important target audience in serious game development – not just as subject matter experts, but also as users and players of the game – with a different set of needs than the learners. Moreover, serious gaming involves more than in-game activities, it also involves actions and events that occur off-game. These activities must also be considered when designing and utilising games for learning and training. A main concern for both educators and scholars of serious games is whether or not games are beneficial for learning and, more to the point, if the quality of learning that they provide is such that they are a good investment for educational organisations. Lately, several scholars have called for a shift of focus from the game itself, to the practicalities and potential barriers for actually using serious games [6]–[11].

This paper aims to describe the current state in research on instructor-led serious gaming and its implications for the design of serious gaming environments. It brings together a comprehensive set of sources which, to varying degrees, discuss instructor roles and the practicalities of planning and carrying out learning activities involving games and game technology.

II. Instructor roles in serious gaming

In serious gaming, instructors can have varying roles depending on their perspective of learning. They also transition between different roles, depending on the current situation, and they may also take on several roles at the same time. Table I summarises instructor roles discussed in this paper.

A. Facilitator

The most common role mentioned in serious game literature is that of facilitator and is here used as an umbrella term. The terms coach, trainer or tutor are sometimes used as synonyms, although coach is mostly used for the more specific in-game facilitator [6], [12]. A facilitator is most often a teacher or instructor, but can also have an administrative employment. In non-educational settings (e.g. games used in healthcare or rehabilitation), the facilitator is any professional (e.g. physical therapist) responsible for the serious gaming activities. Facilitators provide structure and guidance to a learning experience, rather than providing the correct answers in an authoritarian way [13]–[18]. This guidance can be more or less active. For instance, during the introduction or briefing of a game, the facilitator has a key role in making sure that all participants comprehend the notion of serious gaming, which is critical to the learning process [19]. The introduction sets the tone and atmosphere of the game, as well as the style of guidance [19]. An in-game scripted introduction would most likely be unable to capture these subtle nuances as effectively as a human facilitator, especially in dealing with critical participants, false expectations or group tensions [20].

TABLE I. SUMMARY OF THE MOST COMMON TYPES OF INSTRUCTOR ROLES. PLEASE NOTE THAT SOME OF THESE ROLES ARE NOT EXCLUSIVE TO INSTRUCTORS. FOR INSTANCE, AN IT SUPPORT TECHNICIAN CAN ALSO PROVIDE TECHNICAL SUPPORT, ESPECIALLY FOR MORE ADVANCED ISSUES.

Instructor role	Description
Facilitator	Provides structure and guidance, motivates and paces the experience, gives feedback and meta-cognitive aid.
Debriefer	Encourages off-game reflection/reflection-on-action by guiding learners in analysing and interpreting their in-game experience and performance, and provides a cool-down event.
Coach or in-game facilitator	Provides guidance and formative feedback as the game is in progress and scaffolds in-game performance (i.e. acts as director, process manager, game master).
Player or participant	An extreme form of in-game facilitator who participates in the game as a player or puckster.
Off-game facilitator	Observes the game's progression from a detached and passive (fly-on-the-wall) position.
Leader	Stays in control of the learning experience without taking an authoritarian position.
Expert	Provides content expertise during the preparation of game-based learning (e.g. scenario authoring) and in assessing learner performance.
Subject matter expert	Provides content expertise during game development.
Champion	Promotes game-based learning practices at the workplace.
Technical support	Provides help with technical issues related to game-based learning practices.

B. Debriefer

The facilitator is also active in another obvious part of a game-based learning experience and that is in the debriefing. The instructor role is then as debriefer, that is, someone who guides reflection-on-action, assesses the performance, and makes sure that everyone goes away emotionally unscathed [17], [18], [21]. Between-game debriefings also allow the facilitator to "influence the subsequent run of the game by allowing participants to reflect on its progression and to formulate actions for improvement together" [19, p. 187]. Thus, the facilitator plays a critical role in the transfer process, by guiding participants towards a reflective practice, in which making connections between the game and the work practices are fostered [22].

C. In-game facilitator or coach

With regard to the facilitators' activities during gameplay, the role is less clear-cut and ranges from active participant in the gaming experience to passive observer [21]. In adult learning, instructors play a pivotal role in facilitating a change in behaviour from a mere acceptable level of performance to one that will excel at work tasks [23, p. 667]:

> Some researchers suggest a facilitator is doing well when participants scarcely notice their presence. However, a facilitator must always remain sufficiently active in the background to ensure arrival at an appropriate end point. Additionally, they must be present in a very focused and observing manner to be aware of participants' decision processes and group dynamics. This attentiveness ensures the facilitator can make appropriate regulatory interventions, which is described as a form of "active inactivity"

The in-game facilitator or coach is able to provide just-in-time information and meaningful feedback [6], [10], [24], provide scaffolding by handling some of the learners tasks [25], act as a director or process manager in the learning experience [26]–[28], and has an insider view of the experience that gives depth and legitimacy to the debriefing [29]. Thus, the instructor can, by careful timing of events, create situations in which reflection-in-action can occur.

An extreme form of in-game facilitator that is rarely described in serious game literature is when the instructor him- or herself takes part in the gameplay. The instructor then becomes a participant alongside the learners, by, for instance, collaborating with the learners [10] or controlling one or several avatars (becomes a 'puckster') [30]. More or less 'disguised' as another player, the instructor can provide guidance without breaking the flow of the game [31], [32]. Of course, from an instructor's point of view, gameplay will be a different experience compared to that of the learners. Instructors take on a role that is related to that of game master, which means they have an almost God-like overview of events and can interfere when the game takes the players in a direction that is counter to the instructional goal of the exercise [6], [33]. In contrast, learners only have a limited view of the virtual environment and the events taking place, which reflects the level of information that their role has access to in reality. For instance, a trainee playing as commander will have access to more information than one playing a role with a lower ranking. Instructors, on the other hand, usually have no restrictions tied to their role, no matter what character they play. This can be especially useful if the learners enter 'gamer mode' [34], which could potentially result in learners using methods that work for winning the game, but would be inappropriate in real life. As game master, the instructor could tweak the game in real-time so that learners using a sound strategy would win the game and others would not. Furthermore, a human facilitator is necessary in order to spot when learners enter gamer mode [9]. Letting the instructor join the fun of gameplay is suggested to be more motivating for instructors and, thus, increase their acceptance of serious gaming [31], [35].

Another aspect of the in-game facilitator is that different instructors vary in style; some are very active during gameplay, while others let the game run without too many interventions. In a study of 59 facilitators, Van Kessel and Datema [19] noticed two aspects in which facilitators mainly differed: focus (content or process) and the extent of interventions (many or few). Each combination has its strengths and weaknesses. For instance, the content-focused facilitator who intervenes a lot is able to show all the possibilities of what is to be learned [19]. Interventions can, however, break the fidelity and flow of the game, which will be frustrating and, in the worse case, confusing to the learners [36]. An instructor who is too controlling may fail to facilitate transfer, by giving the participants the 'correct' answer before they have had the opportunity to reflect upon different solutions themselves, which can thus

make the game a frustrating experience [19]. At the other end of the spectrum, the process-focused facilitator who lets the game run its course with no or few interventions will teach the participants to change, but will also miss important opportunities for critical moments of in-game reflection [19]. Consequently, the in-game facilitator must be able to recognise situations where interventions are appropriate and at the same time know when to let the learners explore the game freely. Finding the right balance helps to pace the game, synchronise the participants, and steer them in the right direction when necessary [28], [36].

D. Off-game facilitator

The off-game facilitator, on the other hand, is able to observe the game unfold, from a detached perspective, which can also be useful during debriefing [29], especially as a counterpart to the participants' own views and inferences [37]. Thus, the off-game facilitator is more similar to a-fly-on-the-wall instructor role [16]. It is worth noting, however, that complete detachment from the gameplaying stage, even as a passive observer, is not advisable, since "debriefing is likely to be rather general and abstract, for it is more difficult now to discuss specific experiences of participants or concrete events that did take place. Important to note is that this way to proceed will give participants the impression that their behaviours were highly predictable" [37, p. 81]. Consequently, a combination of both in-game and off-game facilitators can be very powerful [29], [37].

E. Champion or early adopter

Since formal training for serious game instructors is rare, most skilled facilitators have reached their level of expertise through informal channels, such as pure interest or passion for game-based learning [24] or through an organisational infrastructure that encourages instructors to share knowledge and learn from each other's mistakes and successes [13], [15], [38]. This means that existing instructors with interest and competence in serious gaming (so-called champions) should be encouraged to share their knowledge with their less experienced colleagues [24].

F. Technical support

Apart from tasks related to didactics, technical support is another important role or task for the facilitator, which either falls to the instructor or a separate individual or organisation that deals with the more advanced technical issues [39]. Involving digital games, technical problems will always be an issue that might deter instructors from fully embracing serious gaming [40].

G. Subject matter expert

Lastly, some instructors also take on the role of subject matter expert during the development of a particular serious game. As such, they are responsible for making sure that the right content is added to the game and that it is represented correctly [21]. Instructors can also act as subject matter experts as a teaching approach, in which they "teach by example, modeling and encouraging critical thinking as they systematically organize and analyze the subject matter knowledge" [12, p. 221].

III. Benefits and barriers

As should be evident by now, the instructor can and does take on many roles as a facilitator of game-based learning. This has a number of positive implications, such as:

- increased *instructor buy-in* through active involvement in the game production and play [15], [24], [35];
- increased *learner buy-in* and motivation through the presence of the instructor, who legitimises the use of games for serious purposes [24], [41];
- leverage of *emotional aspects* of serious gaming, such as boosting morale [42], decreasing anxiety [24], [42], and establishing rapport between the instructor and the learners [43];
- ensuring that *deliberate practice* [44] is achieved by learners who have yet to become self-monitoring [6];
- avoiding the type of gaming that leads to behaviours unsuitable or even detrimental for specific work practices, such as the behaviours exhibited while in *gamer mode* [34], [45];
- forming or reshaping *communities of practice* in which instructors and learners are all participants in creating shared experiences, and the instructors facilitate learning through advice, coaching and other instructor-learner interactions [27], [28], [46];
- enabling *transfer* of knowledge from the gaming context to the work context by explicit learning and reflective activities [6], [22];
- more *effective learning* through guided discovery and feedback [23], [46]–[48];
- decreasing the need for complex and resource-heavy simulations, since the instructor, as in-game facilitator, adds *complexity, noise, and dynamics* [48].

Most importantly, instructor involvement leads to more high-quality serious gaming [19]. A skilled facilitator is able to make real-time assessments and create an adaptive and dynamic experience that goes beyond the game artefact itself [27], [48]. For instance, Bauman and Wolfenstein [36] claim that instructors can react in real-time to inappropriate in-world behaviour and appearance, such as bullying or contextually unsuitable (avatar) appearance. This is especially useful for aspects of the gaming situation that have not been hard-coded into the game engine or rule set, but important for the learning experience. There are, however, two sides to this coin [49, p. 171]:

> In order to support purely computer-based accurate feedback, the vocabulary of operations and situations in the system has to be specified in advance so that rules can be written. Once deployed, students can only do what the system has been prepared to support. It is considerably harder for instructors, as non-programmers, to modify a computer application when they want to customise it for their courses.

Instructors' lack of programming skills is not the only barrier to instructor-led gaming. Serious game literature mentions the following barriers or potential weaknesses:

- Even if instructors recognise the benefit of being involved in serious game production, they may hesitate in actually

becoming involved, due to *time restraints* and *priorities* towards their teaching duties [8], [21], [50];
- Instructor-led serious gaming implicates *teacher control* instead of learner control, and facilitators who take a directive role, enforce control, and perform a great deal of hand-holding and micromanagement, which is detrimental to learning and the development of self-regulatory skills [13], [36], [51];
- Interferences *break the fidelity or flow* of the game [36] and could cause loss of immersion [52];
- Assessments from human instructors are often *subjective* and comparisons between learners are inaccurate [2];
- Increased *costs* in terms of:
  - loss of return of investment [53],
  - licensing and other expenses [13],
  - labour-intensive and time-consuming individualised instruction or coaching [2], [5],
  - lack of competent facilitators [1], [8], [54], and
  - increased need for technical and pedagogical support for inexperienced instructors [20], [35], [55];
- Practical difficulties in harmonising serious games with the *constraints of the educational setting*, such as time needed for playing a game [8], [20], [50], [56];
- Perceived or real *lack of technology reliability and validity* [8];
- Difficulties in adapting games with *fixed content* [35], [49];
- Difficulties in *following dynamic gameplay in real-time* [1], at least without additional functionalities that support in-game facilitation;
- Difficulties in providing real-time feedback and support when gameplay is *asynchronous and distributed*, such as during a distance course [31];
- Incompatible learning theories with regard to instructor-led serious gaming, such as ill-defined instructor roles [27], or other *organisational obstacles* [38].

The increase in costs is usually considered the most serious barrier to instructor-led game-based learning and is also most often used as the main argument for instructor-less training systems. For example, costs are sometimes cut by reducing instructor hours [15]. However, there "is often an up-front cost—monetary and human resources—to introducing simulation and game-based learning into and across curricula. Once this infrastructure is in place, neglecting the content, pedagogy, or delivery mechanism can be costly" [24, p. 94]. Thus, reducing instructor hours can also reduce training effects, which will lead to mistakes in the workplace. Since monetary costs related to serious gaming usually affect different cost units and training effectiveness is inherently difficult to translate into monetary values, calculating the cost-effectiveness of instructor-led versus instructor-less game-based learning will yield different results, depending on assumptions made about the costs involved [53].

A further concern is that research into serious gaming practices tends to focus on younger learners, while ignoring adult or elderly learner groups [27], [57]. Some of the practical challenges for facilitators, which are applicable in most serious gaming contexts, mentioned in the literature are:

- deciding whether to use serious games and, if so, when to use them [58],
- difficulties persuading other stakeholders to adopt serious gaming within the organisation [59],
- finding or obtaining the time to learn how to practise serious gaming [59],
- identifying which games are available and suitable for the intended learning outcomes [59],
- monetary, staff and technological restrictions [24], [60],
- licensing constraints [54], [61],
- initial efforts in setting up computers and learning the game user interface [56],
- dealing with problems concerning usability and user acceptance [62],
- determining how to practically use games as learning tools [8], [57], [58], [63], and
- receiving formal training specific for teaching with simulations and games [20].

Within the military domain, there is also the trade-off between publicly available games (with realistic scenarios) and the risk of terrorists/enemies misusing them [61].

IV. Possible solutions

There are a number of suggestions to manage these challenges, which can roughly be divided into organisational, technical, and human-computer interaction (HCI) related solutions. The following examples are by no means an exhaustive list of solutions, but rather ideas and suggestions on how to tackle the challenges according to current academic literature. Figure 1 gives an overview of the solutions discussed in this paper.

A. Organisational solutions

Organisational solutions involve creating an infrastructure that facilitates knowledge management at different levels. For instance, formal and informal structures for educating instructors and encouraging them to learn from each other are needed [38], [51]. These efforts should especially focus on understanding the possibilities and limitations of serious games and creating communities of best practices for the sharing of stories [13]. That is, individuals must feel that the act of knowledge sharing will be beneficial for them and reciprocated by other members of their community. Difficulties in knowledge sharing are a well-known issue in knowledge management, but it is still not clear what organisations can do to encourage knowledge sharing [64]. Furthermore, it is important that instructors engage in research, in order to exploit the full potential of game-based learning [24], [50]. In essence, organisational solutions involve making use of the inherent enthusiasm of champions to spread knowledge and increase buy-in, without stifling their enthusiasm through ill-considered reward structures [24]. Another type of organisational solution involves support structures for both pedagogical and technical issues that the instructors might need help with [15], [24].

B. Technical solutions

A great concern for educators is the reliability and validity of the educational system [8]. Technical solutions gear towards either replacing parts of the human instructor's task with a tutoring system or pedagogical agent, or augment the tasks with technical solutions, such as sensors, logging tools and automatic assessment (see e.g. [65]). For instance, many serious

games utilise NPCs to deliver content, tasks, or act as mentors [17], [32]. As such, these pedagogical agents can provide scaffolding and drive the narrative forward [32], [66]. There is also work on the enhancement of virtual agents and human behaviour modelling that tries to alleviate the need for human controllers (or pucksters) in serious gaming or simulation. For instance, a single human puckster can control a group of virtual agents, instead of controlling every individual avatar (see e.g. [30]). Similarly, Sycara and Lewis [67] examine multi-agent systems where the virtual agents support human teams in carrying out their tasks. The challenge for these projects is to create agents that model human behaviour as closely as possible, that is, to make human-avatar interactions natural to the point of being almost indistinguishable from human-human interaction. Another example is AutoTutor, a system that employs natural language to support students learning such subjects as Newtonian physics, computer literacy and scientific reasoning. According to the web site (autotutor.org), the system acts as a dialogue partner with the learner and encourages students "to articulate lengthy answers that exhibit deep reasoning, rather than to recite small bits of shallow knowledge". However, Chatham [54, p. 244] notes that NPCs "are today mostly vending machines and jousting dummies" and not very believable as real humans, when interacting with them for more than a few utterances. His statement remains by and large true today [68]. Most adaptive modelling in games is based on ontologies of game entities (objects, NPCs, story elements) that are combined into modules that fit into the narrative [4]. This means that tutoring systems and other adaptive features are limited to well-defined or quantifiable aspects of the gameplay and narrative, that is, those aspects that can be reduced to algorithms. Although these techniques have proven useful for creating interactive and emergent narratives (see e.g. [66], [69]), we are still far from creating AI-agents that are as adaptive as human instructors, especially when training leadership, decision-making and communication skills [9]. Thus, there is a risk that the dynamics of the exercise are lost when pucksters are replaced with virtual agents. Moreover, human behaviour modelling is an endeavour that many serious game developers avoid, due to developmental costs and technological restrictions among the end users.

Technical solutions that aim to relieve some of the cognitive workload put on human instructors seem to be a more promising approach. Most research efforts have focused on automatic assessment systems that are integrated into the game [5], [50], [70] and many also express the need for more work on debriefing tools [48], [65]. To give an example, Ekanayake et al. [2] created an algorithm that assesses driving behaviour in a driving simulator. The algorithm is not only based on the behavioural evaluation of achievement goals, but also accounts for the player's effort towards achieving those goals, such as the physical pressure on the throttle.

C. HCI related solutions

HCI related solutions are related to technical solutions, but more geared towards higher-order considerations on how the instructor's tasks can be simplified or augmented. Some researchers have examined the challenge of involving instructors in game production and have found a number of solutions. The common denominator between these solutions is scenario authoring tools. For instance, Brennecke [41] suggests that a scenario authoring tool could be designed as a game. In a case study, she tested this by implementing a game-based system for crime scene investigation (CSI) training. The idea was to have a cop-and-robber scenario; the teacher would prepare the training session by playing the game as the antagonist, stealing valuable items in a virtual apartment and leaving clues such as foot- and fingerprints. The students were then given the task of investigating the crime scene and trying to 'outsmart' the teacher. The elegance of this idea is that it encourages instructors with less technical skill to create scenarios, since it involves no other skills than playing the game itself. It might also have a positive motivational effect, especially among instructors who enjoy playing games. To deal with the time pressure issue, scenario development could be carried out by a group of instructors. Stiso et al. [71] outline the development of a Common Instructor Operator System (C-IOS) that supports collaborative and distributed scenario authoring. In order to enable the management of different permissions, that is, who is allowed to alter the scenario at specific times during the development cycle, they created an instructor hierarchy consisting of (i) the lead instructor, (ii) the element instructor, and (iii) the platform instructor. A single instructor can inhabit one or several of these roles, or several instructors can be allocated the same role. The main idea is to distribute the work load over several individuals and to enable scenario authoring by instructor teams that are distributed over remote sites or whose work is asynchronous. Distributed scenario authoring still assumes some level of technical competence among instructors, and therefore another popular research direction is to develop automatic or semi-automatic scenario generation [72]. The goal is to relieve instructors of some of the time consuming work, by offering scenario authoring through the 'touch of a button'. Although these solutions still require some scripting skills, the aim is to generate adaptive scenarios from data about player preferences, skill level, game actions, and so on [73]. If successful, these scenarios will be able to adapt to the individual learner's performance, making scenario authoring fully automatic, yet retaining the dynamic nature of manual authoring.

Usability is, of course, a key issue in HCI related solutions, as well as different interfaces specialised to visualise different aspects of the ongoing gameplay and the learners' performance, such as instructor dashboards, HUDs and other control tools [65]. Automatic assessments also need to present measurements to instructors, in a comprehensive and concise way, for use in both formative feedback (e.g. interventions) and debriefings [5]. For instance, Raybourn [48] highlights the importance of being able to bookmark specific events during gameplay, which the instructor wants to re-play during the debriefing later on. This implies that the system needs to not only include logging functionality, but also access to the logs in real-time, through some kind of instructor interface, where events are clear, distinct and selectable. It also implies that the debriefing tool functionality must be able to re-play recorded events, preferably from different angles [48].

Although many instructor tools can be added as features in a system adjacent to the game (e.g. a separate debriefing module), I would argue that a more elegant solution would be to integrate these features within the serious game itself, if possible. This would make transitions between different instructor roles more fluid and flexible, without the need to

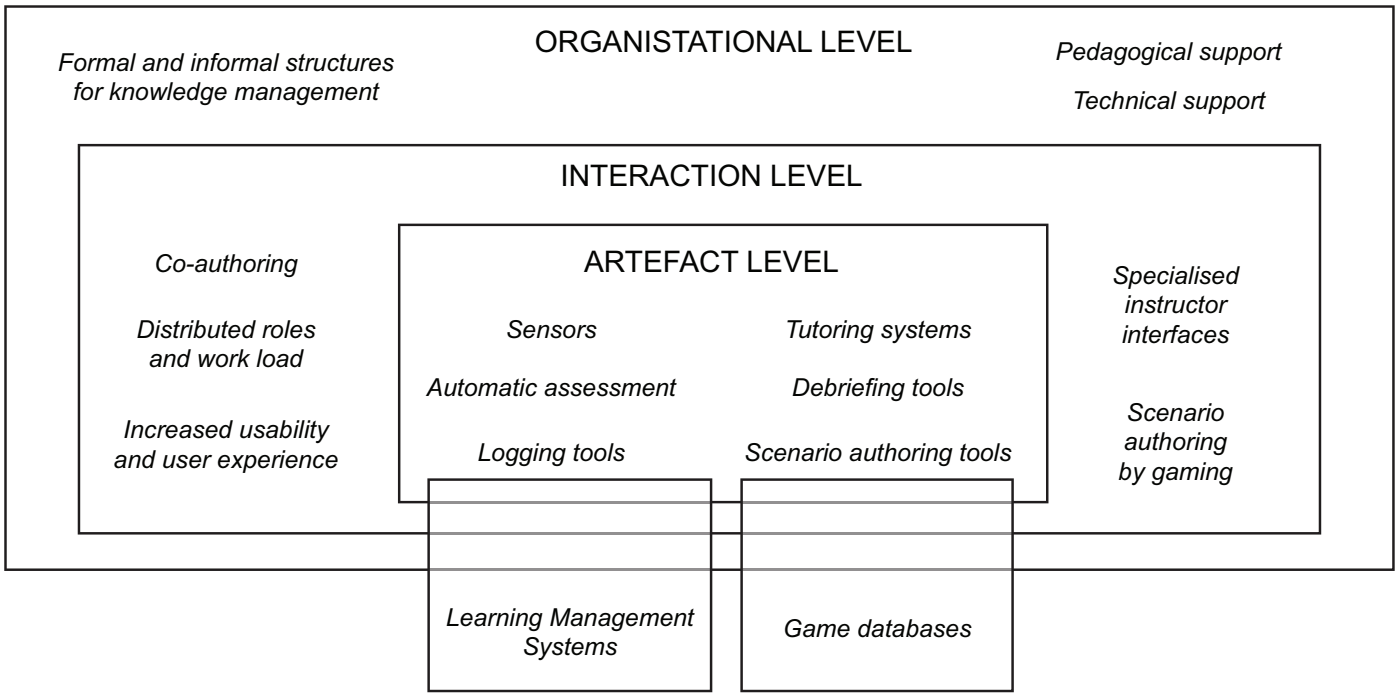

Fig. 1. Overview of possible solutions to tackle the challenges in instructor-led serious gaming

switch program or workstation, and also reduce the costs of educating instructors in different systems.

D. Additional solutions

There are also a few endeavours that are not as easily categorised into organisational, technical or HCI related solutions, but rather span all three. For instance, some efforts have been in the area of integrating serious games into learning management systems, from which games can be introduced, launched and administrated (see e.g. [74]). More recent research is also focused on supporting teachers in the choice of suitable games, by providing databases for sharing the experiences of using specific games (e.g. [75]).

V. Conclusion and future work

In sum, instructors shift between different roles during serious gaming and it is important to not treat them as having only one role. Their main role is that of facilitator, which in turn has different characteristics, depending on the situation and instructional goal. Key roles identified in the literature are debriefer, coach or in-game facilitator, player/participant, off-game facilitator, leader, expert, and technical support. Each of these roles comes with a different set of needs and requirements that must be met in order for serious gaming to run smoothly. Apart from the above mentioned roles, some instructors also take on the roles of subject matter expert and champion, which are broader roles used outside the training situation. Thus, the instructor role extends past the here-and-now serious gaming to situations where experienced instructors introduce novices to the serious gaming practices, or are involved in game production. Furthermore, there are many ways of dealing with the barriers to instructor-led game-based learning, of which I have identified three broad themes: organisational, technical and HCI related solutions.

Instructor-led serious gaming means there is an increased need for instructors with not only high levels of expertise in both pedagogical issues as well as running a simulation, but also able to externalise their knowledge in order to accommodate a culture of cognitive apprenticeship.

This paper makes a case for instructor-led serious gaming, by providing a comprehensive overview of the state of the art in instructor-led serious gaming. It points to the importance of studying the socio-cultural context and off-game activities involved in serious gaming, as well as the importance of designing for user acceptance and user experience, where the instructors form a significant user group. It also highlights the notion of instructors as facilitators who play an important role in helping learners transfer knowledge from the gaming situation to the work context, and the different facilitation techniques that can be used in serious gaming environments.

So far, most work within this area is concentrated on theoretical work and single case studies. However, in order to fully explore the potential and power of serious games, we need more comparative and longitudinal studies. For instance, what instructor roles and needs are associated with specific types of games and educational settings? In order to answer such questions, we need to study not only contexts in which serious gaming is still a novel practice, but also environments where games have been employed for a longer time period.

References

[1] I. Goldstein and B. Carr, "The computer as coach: As athletic paradigm for intellectual education," in *Proc. of the 1977 annual ACM conference*. ACM, 1977, pp. 227–233.

[2] H. Ekanayake, P. Backlund, T. Ziemke, R. Ramberg, and K. P. Hewagamage, "Assessing performance competence in training games," in *Affective Computing and Intelligent Interaction. Proc. of ACII'11, Part II*, ser. Lecture Notes in Computer Science, S. D'Mello, A. Graesser,

B. Schuller, and J.-C. Martin, Eds. Memphis, TN: Springer, 2011, pp. 518–527.

[3] C. Franzwa, Y. Tang, and A. Johnson, "Serious game design: Motivating students through a balance of fun and learning," in *Proc. of VS-Games'13*, 2013, pp. 17–23.

[4] M. D. Kickmeier-Rust and D. Albert, "Emergent design: Serendipity in digital educational games," in *Virtual and Mixed Reality*, ser. Lecture Notes in Computer Science, R. Shumaker, Ed. Berlin: Springer, 2009, vol. 5622, ch. 24, pp. 206–215.

[5] S. M. Stevens-Adams, J. D. Basilico, R. G. Abbott, C. J. Gieseler, and C. Forsythe, "Performance assessment to enhance training effectiveness," in *Proc. of I/ITSEC'10*, 2010.

[6] A.-S. Alklind Taylor, P. Backlund, and L. Niklasson, "The coaching cycle: A coaching-by-gaming approach in serious games," *Simulat. Gaming*, vol. 43, no. 5, pp. 648–672, 2012.

[7] B. Berg Marklund, "Out of context – understanding the practicalities of learning games," in *Proc. of DiGRA'14*. DiGRA, 2014. [Online]. Available: http://www.digra.org/digital-library/publications/out-of-context-understanding-the-practicalities-of-learning-games/

[8] B. Berg Marklund, P. Backlund, and H. Engström, "The practicalities of educational games: Challenges of taking games into formal educational settings," in *Proc. of VS-Games'14*. IEEE Press, 2014.

[9] A. Frank, "The instructor role during educational wargaming," in *Proc. of ISAGA'14*, W. C. Kriz, T. Eiselen, and W. Manahl, Eds., 2014, pp. 153–66.

[10] R. Hämäläinen and K. Oksanen, "Challenge of supporting vocational learning: Empowering collaboration in a scripted 3D game – how does teachers' real-time orchestration make a difference?" *Comput. Educ.*, vol. 59, no. 2, pp. 281–293, 2012.

[11] L. Vos, "Simulation games in business and marketing education: How educators assess student learning from simulations," *Int. J. Educ. Manag.*, vol. 13, no. 1, pp. 57–74, 2015.

[12] A. Y. Kolb, D. A. Kolb, A. Passarelli, and G. Sharma, "On becoming an experiential educator: The educator role profile," *Simulat. Gaming*, vol. 45, no. 2, pp. 204–234, 2014.

[13] H. Axe and H. Routledge, "Practical applications of serious games in education," in *Handbook of research on improving learning and motivation through educational games: Multidisciplinary approaches*, P. Felicia, Ed. Hershey, PA: IGI Global, 2011, ch. 44, pp. 961–973.

[14] B. Berg Marklund, P. Backlund, C.-J. Dahlin, H. Engström, and U. Wilhelmsson, "A game-based approach to support social presence and awareness in distributed project-based learning," *IJGBL*, vol. 4, no. 1, pp. 1–20, 2014.

[15] W. R. Bickley, R. J. Pleban, F. Diedrich, J. Sidman, R. Semmens, and A. Geyer, "Army institutional training: Current status and future research," U.S. Army Research Institute for the Behavioral and Social Sciences, Research Report, 2010. [Online]. Available: http://www.dtic.mil/cgi-bin/GetTRDoc?Location=U2&doc=GetTRDoc.pdf&AD=ADA516971

[16] G. J. Hofstede, L. de Caluwé, and V. A. M. Peters, "Why simulation games work—in search of the active substance: A synthesis," *Simulat. Gaming*, vol. 41, no. 6, pp. 824–843, 2010.

[17] J. R. Kirkley, T. M. Duffy, S. E. Kirkley, and D. L. H. Kremer, "Implications of constructivism for the design and use of serious games," in *Computer games and instruction*, S. Tobias and J. D. Fletcher, Eds. Charlotte, NC: Information Age Publishing, 2011, ch. 14, pp. 371–394.

[18] L. Ukens, "Learning games: Hands-on participant-centered activities," in *The handbook of experiential learning*, M. Silberman, Ed. San Francisco: Pfeiffer, 2007, ch. 7, pp. 124–137.

[19] M. van Kessel and H. Datema, "Facilitators: Quality, style and attitude," in *Why do games work? In search of the active substance*, L. de Caluwé, G. J. Hofstede, and V. Peters, Eds. Deventer: Kluwer, 2008, ch. 16, pp. 183–189.

[20] G. Der Sahakian, G. Alinier, G. Savoldelli, D. Oriot, M. Jaffrelot, and F. Lecomte, "Setting conditions for productive debriefing," *Simulat. Gaming*, 2015. [Online]. Available: http://dx.doi.org/10.1177/1046878115576105

[21] W. H. Tan, S. Neill, and S. Johnston-Wilder, "How do professionals' attitudes differ between what game-based learning could ideally achieve and what is usually achieved," *IJGBL*, vol. 2, no. 1, pp. 1–15, 2012.

[22] S. Bronack, R. Sanders, A. Cheney, R. Riedl, J. Tashner, and N. Matzen, "Presence pedagogy: Teaching and learning in a 3D virtual immersive world," *IJTLHE*, vol. 20, no. 1, pp. 59–69, 2008.

[23] W. C. Kriz, "A systemic-constructivist approach to the facilitation and debriefing of simulations and games," *Simulat. Gaming*, vol. 41, no. 5, pp. 663–680, 2010.

[24] E. B. Bauman, "Preparing faculty and students for game-based and virtual learning spaces," in *Game-based teaching and simulation in nursing and healthcare*, E. B. Bauman, Ed. New York, NY: Springer, 2013, ch. 4, pp. 77–98.

[25] J. M. Beaubien and D. P. Baker, "The use of simulation for training teamwork skills in health care: how low can you go?" *Qual. Saf. Health Care*, vol. 13, no. suppl 1, pp. i51–i56, 2004.

[26] M. Checa-Romero, "Developing skills in digital contexts: Video games and films as learning tools at primary school," *Games Cult.*, 2015. [Online]. Available: http://dx.doi.org/10.1177/1555412015569248

[27] A. Frank, "Balancing three different foci in the design of serious games: Engagement, training objective and context," in *Proc. of DiGRA'07: Situated Play*, B. Akira, Ed., 2007, pp. 567–574. [Online]. Available: http://www.digra.org/wp-content/uploads/digital-library/07312.29037.pdf

[28] M. G. Wagner and T. Wernbacher, "Iterative didactic design of serious games," in *Proc. of FDG'13*, 2013, pp. 346–351. [Online]. Available: http://www.fdg2013.org/program/papers/paper45_wagner_wernbacher.pdf

[29] L. de Caluwé, "The active substance from the perspective of change," in *Why do games work? In search of the active substance*, L. de Caluwé, G. J. Hofstede, and V. Peters, Eds. Deventer: Kluwer, 2008, ch. 7, pp. 79–89.

[30] J. Colonna-Romano, W. Stacy, M. Weston, T. Roberts, M. Becker, S. Fox, and G. Paull, "Virtual puckster – behavior generation for army small team training and mission rehearsal," in *Proc. of BRIMS'09*, 2009, pp. 153–154.

[31] A.-S. Alklind Taylor and P. Backlund, "Letting the students create and the teacher play: Expanding the roles in serious gaming," in *Proc. of MindTrek'11*. ACM, 2011, pp. 63–70.

[32] D. Charsky, "From edutainment to serious games: A change in the use of game characteristics," *Games Cult.*, vol. 5, no. 2, pp. 177–198, 2010.

[33] M. Villalta, I. Gajardo, M. Nussbaum, J. J. Andreu, A. Echeverría, and J. L. Plass, "Design guidelines for classroom multiplayer presential games (CMPG)," *Comput. Educ.*, vol. 57, no. 3, pp. 2039–2053, 2011.

[34] A. Frank, "Gaming the game: A study of the gamer mode in educational wargaming," *Simulat. Gaming*, vol. 43, no. 1, pp. 118–132, 2012.

[35] A. Brennecke and H. Schumann, "A general framework for digital game-based training systems," in *Proc. of IADIS GET'09*, 2009, pp. 51–58. [Online]. Available: http://www.iadisportal.org/digital-library/a-general-framework-for-digital-game-based-training-systems

[36] E. B. Bauman and M. Wolfenstein, "Using virtual and game-based learning to prepare for actual practice," in *Game-based teaching and simulation in nursing and healthcare*, E. B. Bauman, Ed. New York, NY: Springer, 2013, ch. 5, pp. 99–125.

[37] V. A. M. Peters and G. A. N. Vissers, "A simple classification model for debriefing simulation games," *Simulat. Gaming*, vol. 35, no. 1, pp. 70–84, 2004.

[38] T. D. Henriksen and S. Löfvall, "Integrating learning games in higher education – from technical to organisational obstacles," in *Proc. of ISAGA'13)*, ser. KTH Transport Science publication series, S. A. Meijer and R. Smeds, Eds., 2013.

[39] R. Sandford, M. Ulicsak, K. Facer, and T. Rudd, "Teaching with games: using commercial off-the-shelf computer games in formal education," Futurelab, Project Report, 2007. [Online]. Available: http://www2.futurelab.org.uk/resources/documents/project_reports/teaching_with_games/TWG_report.pdf

[40] S. Egenfeldt-Nielsen, "Practical barriers in using educational computer games," in *Beyond fun: Serious games and media*, D. Davidson, Ed. Pittsburgh: ECT Press, 2008, p. 30–36.

[41] A. Brennecke, "A general framework for digital game-based training systems," Doctoral thesis, University of Rostock, 2009. [Online].

Available: http://rosdok.uni-rostock.de/file/rosdok_derivate_0000000003979/Dissertation_Brennecke_2009.pdf

[42] G. J. Hofstede, "One game does not fit all cultures," in *Why do games work? In search of the active substance*, L. de Caluwé, G. J. Hofstede, and V. Peters, Eds. Deventer: Kluwer, 2008, ch. 6, pp. 69–77.

[43] R. D. Duke, "One perspective on the 'active substance' of gaming simulations," in *Why do games work? In search of the active substance*, L. de Caluwé, G. J. Hofstede, and V. Peters, Eds. Deventer: Kluwer, 2008, ch. 1, pp. 27–30.

[44] K. A. Ericsson, "Enhancing the development of professional performance: Implications from the study of deliberate practice," in *Development of professional expertise: Toward measurement of expert performance and design of optimal learning environments*, K. A. Ericsson, Ed. New York: Cambridge University Press, 2009, ch. 18, pp. 405–431.

[45] A. Frank, "Achieving game goals at all costs? – the effect of reward structures on tactics employed in educational military wargaming," in *Proc. of ISAGA'13*, ser. KTH Transport Science publication series, S. A. Meijer and R. Smeds, Eds., 2013.

[46] H. Leemkuil and T. de Jong, "Instructional support in games," in *Computer games and instruction*, S. Tobias and J. D. Fletcher, Eds. Charlotte, NC: Information Age Publishing, 2011, ch. 13, pp. 353–369.

[47] R. Moreno and R. E. Mayer, "Role of guidance, reflection, and interactivity in an agent-based multimedia game," *J. Educ. Psychol.*, vol. 97, no. 1, pp. 117–128, 2005.

[48] E. M. Raybourn, "Applying simulation experience design methods to creating serious game-based adaptive training systems," *Interact. Comput.*, vol. 19, no. 2, pp. 206–214, 2007.

[49] L. Qiu and C. K. Riesbeck, "An incremental model for developing computer-based learning environments for problem-based learning," in *Proc. of IEEE Int. Conf. on Advanced Learning Technologies*, 2004, pp. 171–175.

[50] E. Tsekleves, J. Cosmas, and A. Aggoun, "Benefits, barriers and guideline recommendations for the implementation of serious games in education for stakeholders and policymakers," *Brit. J. Educ. Technol.*, 2014. [Online]. Available: http://dx.doi.org/10.1111/bjet.12223

[51] A. Walker and B. E. Shelton, "Problem-based educational games: Connections, prescriptions, and assessment," *J. Interact. Learn. Research*, vol. 19, no. 4, pp. 663–684, 2008.

[52] I. Ghergulescu and C. H. Muntean, "Motivation monitoring and assessment extension for input-process-outcome game model," *IJGBL*, vol. 4, no. 2, pp. 15–35, 2014.

[53] J. D. Fletcher, "Cost analysis in assessing games for learning," in *Computer games and instruction*, S. Tobias and J. D. Fletcher, Eds. Charlotte, NC: Information Age Publishing, 2011, ch. 16, pp. 417–434.

[54] R. E. Chatham, "Toward a second training revolution: Promise and pitfalls of digital experiential learning," in *Development of professional expertise: Toward measurement of expert performance and design of optimal learning environments*, K. A. Ericsson, Ed. New York: Cambridge University Press, 2009, ch. 10, pp. 215–246.

[55] G. A. Gunter, R. F. Kenny, and E. H. Vick, "Taking educational games seriously: using the RETAIN model to design endogenous fantasy into standalone educational games," *Educ. Tech. Res.*, vol. 56, no. 5–6, pp. 511–537, 2008.

[56] S. Egenfeldt-Nielsen, "Overview of research on the educational use of video games," *Digital Kompetanse*, vol. 1, pp. 184–213, 2006.

[57] F. Ke, "A qualitative meta-analysis of computer games as learning tools," in *Handbook of Research on Effective Electronic Gaming in Education*, R. E. Ferdig, Ed. Hershey, PA: IGI Global, 2009, ch. 1, pp. 1–32.

[58] R. L. Appelman and J. H. Wilson, "Games and simulations for training: From group activities to virtual reality," in *Handbook of human performance technology*, 3rd ed., J. A. Pershing, Ed. San Francisco: Pfeiffer, 2006, ch. 17, pp. 414–436.

[59] J. Kirriemuir and A. Mcfarlane, "Literature review in games and learning," Futurelab, Tech. Rep. hal-00190453, version 1, 2004. [Online]. Available: http://telearn.archives-ouvertes.fr/docs/00/19/04/53/PDF/kirriemuir-j-2004-r8.pdf

[60] P. Backlund and M. Hendrix, "Educational games – are they worth the effort? a literature survey of the effectiveness of serious games," in *Proc. of VS-Games'13*, 2013, pp. 69–76.

[61] M. Ford, M. Barlow, and E. Lewis, "An initial analysis of the military potential of cots games," in *Proc. of SimTecT'03*, 2003.

[62] A. Padrós, M. Romero, and U. Mireia, "Developing serious games: from face-to-face to a computer-based modality," elearningeuropa.info, 2011. [Online]. Available: http://elearningpapers.eu/en/article/Developing-Serious-Games%3A-from-Face-to-Face-to-a-Computer-based-Modality

[63] P. G. Schrader and M. McCreery, "Are all games the same?" in *Assessment in game-based learning: Foundations, innovations, and perspectives*, D. Ifenthaler, D. Eseryel, and X. Ge, Eds. New York, NY: Springer, 2012, ch. 2, pp. 11–28.

[64] M.-J. J. Lin, S.-W. Hung, and C.-J. Chen, "Fostering the determinants of knowledge sharing in professional virtual communities," *Comput. Hum. Behav.*, vol. 25, no. 4, pp. 929–939, 2009.

[65] A.-S. Alklind Taylor and P. Backlund, "Making the implicit explicit: Game-based training practices from an instructor perspective," in *Proc. of ECGBL'12*, P. Felicia, Ed. ACI, 2012, pp. 1–10.

[66] F. Bellotti, R. Berta, and A. De Gloria, "Designing effective serious games: Opportunities and challenges for research," *iJET*, vol. 5, pp. 22–35, 2010.

[67] K. Sycara and M. Lewis, "Integrating intelligent agents into human teams," in *Team cognition: Understanding the factors that drive process and performance*, E. Salas and S. M. Fiore, Eds. Washington, DC: APA, 2004, ch. 10, pp. 203–231.

[68] J. Brusk, "Step towards creating socially competent game characters," Doctoral Dissertation, University of Gothenburg, 2014. [Online]. Available: http://hdl.handle.net/2077/34774

[69] M. D. Kickmeier-Rust, E. Mattheiss, C. Steiner, and D. Albert, "A psycho-pedagogical framework for multi-adaptive educational games," *IJGBL*, vol. 1, no. 1, pp. 45–58, 2011.

[70] F. Bellotti, B. Kapralos, K. Lee, P. Moreno-Ger, and R. Berta, "Assessment in and of serious games: An overview," *Adv. Hum. Comput. Interact.*, vol. 2013, 2013, article ID: 136864.

[71] M. E. Stiso, J. M. Owens, J. E. Fowlkes, S. Eitelman, A. Hafich, M. M. Walwanis Nelson, and D. G. Smith, "Framework for a common instructor operator system, part 1: Enabling scenario development," in *Proc. of BRIMS'04*. Simulation Interoperability Standards Organization (SISO), 2004, pp. 102–111.

[72] G. A. Martin, C. E. Hughes, S. Schatz, and D. Nicholson, "The use of functional L-systems for scenario generation in serious games," in *Proc. of PCGames'10*. ACM, 2010.

[73] R. Lopes and R. Bidarra, "Adaptivity challenges in games and simulations: A survey," *IEEE Trans. Comput. Intell. AI in Games*, vol. 3, no. 2, pp. 85–99, 2011.

[74] J. Torrente, P. Moreno-Ger, I. Martínez-Ortiz, and B. Fernandez-Manjon, "Integration and deployment of educational games in e-learning environments: The learning object model meets educational gaming," *Educ. Technol. Soc.*, vol. 12, no. 4, pp. 359–371, 2009.

[75] M. Hendrix, P. Backlund, M. Lebram, and H. Lundqvist, "Sharing experiences with serious games: The EduGameLab rating tool for parents and teachers," in *Proc. of VS-Games*, 2013, pp. 138–141.