A Serious-Game Framework to Improve Physician/Nurse Communication

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Abstract. This paper focuses on a serious-game framework for a dialogue-driven game called GLIMPSE (A **G**ame to **L**earn **I**mportant Communications **M**ethods for **P**atient **S**afety **E**nhancement). The eight essential components of the framework include: recommended communication behavior; accurate translation; narrative-driven, role-playing episodes that allow practice in different challenging situations; perspective sharing mechanisms; a design paradigm that accommodates time challenges of participants; motivational gameplay rewards; feedback/assessment mechanisms; and curriculum. The paper explores how the framework was developed as well as implementation challenges, lessons learned and opportunities for future research.

Keywords: Dashboards · Interprofessional communication · Narrative systems · Patient safety · Perspective sharing · Persuasive technology · Physician/nurse communication · Role-playing · SBAR · Serious games · Serious game framework · Team-based communication · Learning portals

1 Introduction

This paper focuses on a serious-game framework for a dialogue-driven serious game called GLIMPSE (A **G**ame to **L**earn **I**mportant Communications **M**ethods for **P**atient **S**afety **E**nhancement). GLIMPSE was a research project completed in March 2015 sponsored by the Agency for Healthcare Research and Quality (AHRQ). The research was done in collaboration with the Virtual Humans and Synthetic Societies Lab within the Modeling and Simulation Center at the University of Texas at Dallas, The College

of Nursing at the University of Texas at Arlington and Baylor Scott & White Health. The game's purpose is to increase perspective sharing and role empathy among physicians and nurses as a way to improve communication and ultimately patient safety. The project focuses on a critical topic in medical practice today. "Current research indicates that ineffective communication among healthcare professionals is one of the leading causes of medical errors and patient harm" [1]. To this end, communication improvement and interprofessional teamwork is a major theme of healthcare professional education, and new interface strategies for learning and practicing effective communication are an important research area.

2 Characteristics of the Design Challenge

Several distinct design challenges and opportunities exist with the physician-nurse audience that is the target of GLIMPSE. Physicians and nurses have limited time for work place education. Changing schedules, expected turnover and similar issues add to the basic availability of the target users. This schedule variability lends itself to the need for asynchronous time paradigms where participants can work independently at their own pace, and yet, at other times synchronous learning opportunities may be desired. Another characteristic of communications-based education is that it inherently requires role-playing and perspective sharing. This requirement is difficult to portray realistically without virtual characterization which a gaming paradigm can provide. A game provides a setting where physicians and nurses can practice sensitive or potentially inflammatory situations within a safe environment. A serious game construct includes the ability to represent complex relationships, nuance and levels and the flexibility to represent individual and team dynamics. Just-in-Time training and expandability is another characteristic that game-based frameworks can provide. Users can review the game content at will. Growth in computer-based, mobile and tablet paradigms encourages research in serious-game frameworks. An episodic game provides chunked story-based narrative content that fits the periodic training timeframes of working medical professionals. A game-based format allows for ongoing onboarding of new staff on organizational culture. A game paradigm can provide motivation, feedback and assessment opportunities. A serious game framework provides a persuasive technology paradigm that encourages behavioral change. Finally, communication fits well into a serious game construct.

3 Communication Is a Game

The daily interactions of healthcare professionals often resemble an intricate and challenging game. In real life, physicians and nurses daily gain and lose relationship points because of communication. Stress, lack of sleep, cultural and social barriers, emergencies, and professional rank and status are just some of the variables that may cause communication breakdowns and ensuing negative patient outcomes. When healthcare professionals do not address problems, voice concerns, or show respect, patients can suffer. Just as in real life, in GLIMPSE, a player wins interaction points, or

iPoints, by being courteous and showing respect, by taking opportunities to repair relationships, and by using the recommended communication techniques. A player can lose iPoints by showing anger, letting their ego guide their communication decisions, or by failing to use recommended communication techniques. In GLIMPSE players have the opportunity to step out of their usual professional role and explore other perspectives. This perspective-sharing capability allows players to experience how cultural differences, professional responsibilities, and perceived social status along with personality conflicts and workplace distractions affect communication.

4   Similar Research

"Serious games applications related to health and healthcare are becoming more common, and today there exists a large number of them" [2]. Furthermore, "high-fidelity medical simulations are educationally effective and simulation-based education complements medical education in patient care settings" [3]. Yet research into the effectiveness of virtual reality, game-based simulations for medical education and healthcare workforce training has been limited. Most validation studies of virtual simulation and training-type games focus on a narrow set of surgical skills such as laparoscopic and endoscopic training [4]. Very little has been published on how to implement fuller, organization-wide curriculum characteristics such as interprofessional team-based communication, perspective sharing, patient-centered "just culture" which balances safety and accountability [5], and behavioral/attitudinal changes that lead to improved outcomes, into a serious game experience. One study in the defense sector proposes a design framework called the "simulation experience design method" which focuses on "designing user supports for cross-cultural discovery by way of interactions, narratives, how communication defines a place, and how user co-created emergent culture could result in more intrinsically motivating virtual environments that in turn engender more equitable intercultural communication" [6]. Another healthcare game design study [7] concludes "designing healthcare games based on behavioral models can increase the usability of the game in order to improve the effectiveness of the game's desired healthcare outcomes." These studies suggest a need for research on how educational designers can create rich systems of experiences for healthcare simulation and training.

5   Gamification, Serious Games and Persuasive Technology

The terms gamification and serious games are often used interchangeably, but they are not synonymous. A clarification of these terms is helpful for defining the framework. Further, a discussion of the characteristics of persuasive technology is also helpful for framework conceptualization.

Gamification is the use of game design elements and game mechanics such as badges and leaderboards in non-game contexts [8]. For example, Dominguez and colleagues explored the value of gamifying an online course on "Qualification for Users of ICT (Information and Communications Technology)" [8]. In contrast, serious

games are complete original games for non-entertainment purposes [9]. Clearly, the GLIMPSE research is a serious game.

Interestingly, the research of B.J. Fogg on persuasive technology directly parallels the framework findings, and in particular the research process to create GLIMPSE. Fogg defines persuasive technology as "an interactive product designed to change attitudes or behaviors or both by making a desired outcome easier to achieve" [10]. Fogg identifies seven types of persuasive technology tools that relate to the components of the framework described here including *reduction* or simplifying, *tailoring* or "computer products relevant to individuals to change attitudes or behaviors," and *suggestion technology* or "an interactive product that suggests a behavior at the most opportune moment" [10].

6 A Serious-Game Framework to Improve Physician/Nurse Communication

Given the game parameters and requirements, the following eight key elements of A Serious-Game Framework to Improve Physician/Nurse Communication are proposed. These eight essential components include: recommended communication behavior; accurate translation; narrative-driven, role-playing episodes that allow practice in different challenging situations; perspective-sharing mechanisms; a design paradigm that accommodates time challenges of participants; motivational gameplay rewards; feedback/assessment mechanisms; and curriculum. These are discussed below.

6.1   Recommended Communications Behavior

Within the GLIMPSE game, two goal behavior paradigms were presented: Situation, Background, Assessment, Recommendation (SBAR), and Team-based Communication (TBC). Each of these are discussed below.

Situation Background Assessment Recommendation (SBAR). Mnemonic tools such as SBAR, AIDET (acknowledge, introduce, duration, explanation, thank you) and PACE (patient problem, assessment, continuing changes, evaluation) are used in healthcare environments to facilitate interprofessional and patient/provider communication [11, 12]. SBAR was created by the military and adopted in healthcare to promote effective and consistent communication among providers. The tool's effectiveness has been evaluated from a quality improvement and research perspective with results suggesting that the tool improves handoffs, rounding, interdisciplinary communication and patient safety [13, 14]. The Institute for Health Improvement endorsed SBAR [15] because its use promotes standardization of communication. GLIMPSE includes interactive episodes to teach SBAR and how it might be adapted for different communications situations in order to reduce errors and promote quality patient care.

Team-Based Communication (TBC). As teams bring together individuals with different social status, communication patterns likely reflect these differences and can

reinforce a hierarchical team structure [16]. For instance, surveys of critical care physicians and nurses revealed differences in their understanding of teamwork consistent with their status [17, 18]. Physician responses suggest they perceived themselves as the ones who give orders to nurses, whereas nurses reported difficulties in expressing concerns or criticism. Research on pilot communication shows that such status-based communication may undermine effective teamwork [19–21] and can generate complacency. High-status team members might discourage subordinates from speaking up and might misunderstand the intentions of subordinates or dismiss their suggestions.

An alternative to status-based communication is "team-centered communication," which was presented in GLIMPSE as "team-based communication" to avoid confusion with other types of team training. Fischer [22] uses the "team-centered communications" term to characterize strategies that emphasize team members' shared responsibilities for solving a problem. Team-centered communication does not deny differences in status, experience and expertise among team members, but these differences are not used to elevate the views of an individual or to curtail communication between team members. Team-centered communication is grounded in the team members' understanding that they are jointly responsible for accomplishing a task. Team-centered communication is a generic model. Although it was developed for and tested with cockpit crews [19], its underlying assumptions are applicable to other domains. Game design incorporated the model's concepts into dialog and gameplay.

6.2 Accurate Translation

A game designed to affect face-to-face behavior must translate to the workplace. Translation includes physical environment, gameplay, narrative and dialog authenticity and realism, rewards and assessments. For example, research revealed that administration, physicians, nurses and patients occasionally send thank you notes as illustrated by A(1) and B(1) in Fig. 1. This reward system is integrated into GLIMPSE.

Fig. 1. GLIMPSE included personal (A) and team (B) dashboards to track progress

6.3   Narrative-Driven, Role-Playing Episodes that Allow Practice in Different Challenging Situations

GLIMPSE is a dialog-driven narrative game. The issues that the simulation addresses are the communication barriers that arise during conversations between physicians and nurses as they care for patients. Conversation choices presented to participants and the resulting dialog from characters reflect the commonplace, and sometimes cultural, communication conflicts that can occur in hospital environments. In the GLIMPSE storyline, an elderly patient presents to the Emergency Department with a hip fracture. The story emerges throughout the episodes from new complications in the patient's condition. The story timeline as presented in Fig. 2 below introduces new conflicts in interactive episodes. The overarching narrative, the dialog and the feedback mechanisms are designed to reflect the patient's perspective of how well her care team works together and to reinforce the two communications strategies, SBAR and TBC. Dialog was written specifically with a four-prong, "4P" strategy. (1) Patient: to always return the focus on patient safety; (2) Perspective sharing: to reflect the differences in how physicians and nurses might communicate. (3) Plausibility: to accurately reflect real-world hospital experiences as well as the teaching objectives. (4) Plot: to quickly move busy, work-distracted professionals along branching narrative paths to accomplish teaching moments in each episode. This "4P" strategy led to the design of dialog game features such as Thought Bubbles, which allow participants to pause and reflect on how their own emotions might affect what is said, and therefore, how the plot might branch as a result. Thought Bubbles reinforce perspective sharing and keep the story focused on the patient.
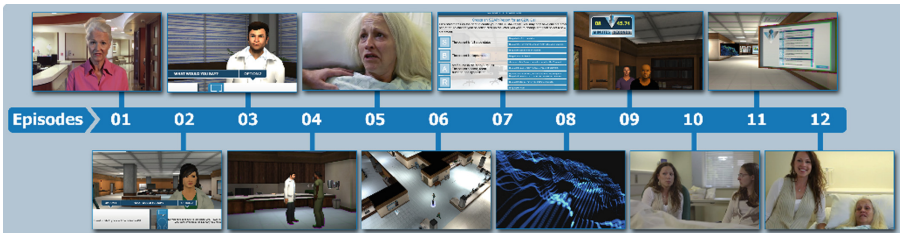

Fig. 2. The story timeline is divided into 12 short episodes that follow a patient through her hospital stay. Interactive episodes engage the player in communications conflicts that arise.

6.4   Perspective-Sharing Mechanisms

As illustrated in A(2) and B(2) in Fig. 1, one perspective-sharing mechanism is that the players pick both doctor and nurse characters before beginning the game and play some episodes as a doctor and some as a nurse, regardless of their real-world roles.

Another perspective-sharing mechanism is the GLIMPSE mechanic, which affords the player the opportunity to hear a character's unspoken thoughts, thereby getting a glimpse into the character's behavior, something that is possible in a gaming virtual environment, but not in real life. The GLIMPSE mechanic helps with perspective

sharing, allowing insight into a virtual colleague's behavior and making players aware of unspoken, underlying emotions. Players also get points for taking the time in the game to get a GLIMPSE. This design is illustrated in E in Fig. 3.

Fig. 3. GLIMPSE simulates a hospital unit (A) and the ability to converse with characters (B, C). The game offers participants immediate feedback on their decisions (D) and perspective sharing through gameplay features like the GLIMPSE mechanic (E).

6.5   A Design Paradigm that Accommodates Time Challenges of Participants

As outlined above, physicians and nurses in general are time challenged, and the nature of their workdays requires design consideration. Further, physicians and nurses do not work the same schedules all the time and may be off work for several days and then return. Synchronous gameplay presents challenges because physicians and nurses would have difficulty collaborating to play the game. While nurses might have an easier time coordinating, that was not the research focus. Therefore an "implied" team paradigm was created where physicians and nurses were assigned to teams and had the opportunity to collaborate and compete with other teams, but actual coordination was not required to progress in the game. Further, as illustrated in B(3) in Fig. 1, a team puzzle which reinforced the goal of a positive patient outcome could be unlocked across episodes by the team. Puzzle pieces were awarded to the first member of the team who completed an episode.

Further accommodating the users, the project was web-based, organized around episodic content and built in the Unity game engine. The purpose of these delivery mechanisms was to allow participants to log in and log out and be able to play a few episodes at a time, at home or at work, as time permitted within approximately a two-week period. Episodes were never more than 10 minute long and were accompanied by transition videos to create lesson and story continuity in the event large gaps of time elapsed before the physicians and nurses continued in the process.

In addition, as illustrated in Fig. 1, a simple dashboard schema was adopted that clearly showed what character selections the physicians and nurses had chosen, what episode the participant was experiencing, number of episodes completed, points earned, badges and thank you notes earned. As shown in Fig. 1, players had both a personal (A) and a team (B) dashboard available.

6.6   Motivational Gameplay Rewards

Several motivational gameplay awards were developed. These include earning interaction points (iPoints) based on choices that reflected the SBAR or TBC recommended approaches, mini-games within some episodes and earned badges. As illustrated in Fig. 1, participants could see their own progress and that of their team and other teams in the cohort through the personal (A) and team (B) dashboards. Players could earn badges, which both rewarded the goals of the game – such as using SBAR and TBC – and encouraged ongoing participation. As illustrated in A(4) and B(4) in Fig. 1, badges were awarded at both the individual player and team level. Continuing education credit was offered to the physicians since the game included ethics content.

6.7   Feedback/Assessment Mechanisms

Feedback was achieved holistically through the dashboard as outlined above and also through step-by-step dialog and Thought Bubble choices, as illustrated in Fig. 3 (B) and (D). All of the data were collected by player and team and are available for analysis. Participants also completed pre- and post-participation knowledge and satisfaction surveys that were part of the game dashboard.

6.8   Curriculum

The curriculum for interprofessional communication was developed based on a literature review, semi-structured interviews with nurses and physicians, and one nurse focus group. The curriculum was presented to participants through all of the mechanisms described above. The interviewees and focus group participants were asked open-ended questions that were sub-grouped into scenarios, strategies used to improve communication and communication challenges. Interviews and the focus group were one to two hours in duration, were audio recorded and transcribed verbatim. The transcripts were then analyzed for descriptive and prescriptive themes, which were then used to inform curriculum development.

The curriculum's key learning objectives were: (a) demonstrate understanding of the consequences of lack of positive communication and collaboration between physicians and nurses, (b) identify common causes of poor physician-nurse communication, and (c) develop approaches to enhancing physician-nurse communication, such as SBAR and TBC, for patient-centered care using a shared-perspective approach. The narrative, episode dialog and gaming components reflected the curriculum and communication challenges identified. Episode scripts and dialog were vetted for accuracy and authenticity by nurses and physicians. The SBAR and TBC recommended communication strategies were also a major part of the implemented curriculum.

7 Implementation Challenges, Lessons Learned and Opportunities for Further Research

GLIMPSE is successful complex research, but was not without implementation challenges, lessons learned and opportunities for further research, as discussed below.

7.1 Implementation Challenges

Implementation challenges were encountered due to the game subject matter, nature of healthcare environments, and technical implementation. Each of these are discussed below.

As mentioned in the framework, it is critical that the narrative represent real-life situations. This requirement created unexpected delays during script development, as editing for authenticity required additional nurse/physician interviews.

Further, during the research timeframe, preparation for regulatory reviews and an increased workload due to holiday and staffing shortages contributed to nursing time constraints. Physicians experienced similar time demands due to scheduling conflicts. Competing priorities including Joint Commission review, Magnet appraiser audit, and visiting regulatory agencies disrupted the continuity of the intervention. These distractions made it difficult to fully engage participants in the activity. The intervention was implemented during the holiday season, causing disruptions in study team site visits and the availability of participants to obtain additional instruction for game completion. Inconsistent use of email by participants made follow-up by study staff problematic. Facility reorganization and employee turnover was distracting to participants and impacted gameplay. Sample size varied among nurses and physicians which made team play challenging. Participants had inconsistent levels of computer literacy, which made it difficult to provide standardized instructions.

The intervention facility was found to have some insufficient computer hardware, software and informatics to support the intervention. Computers varied on individual units. Additional computers were requested and installed at a central location on each unit, requiring additional time and coordination between tech support, nursing and study staff. Web browser changes were required for most computers. The study team was able to provide only limited tech support to participants.

A synchronous gameplay intervention would have been helpful to add to the research to compare response levels, but the research timeline did not permit this added activity. An unanticipated lack of interest in gaming was exhibited by some members of the target audience. Although identified by physicians as a desired component for game design in pre-development research, the competitive aspect of the game did not seem as important in the actual gameplay for some participants. Finally, as illustrated below in Fig. 4, more challenging and unique episodes were sometimes confusing to users and seemed to not always function as designed; this could be due to personal computer age and compatibility. Action items within the research timeline for more interim usability tests with the exact target audience would have been helpful.

Fig. 4. In episode 6 participants were asked to search the environment and click on GLIMPSE icons to unlock audio posters with key game lessons and messages. The episode was studied extensively in the VHSS Lab and refined for ease of use. Despite this testing, this episode was overly challenging to some participants and appeared to not work well on some intervention site computers. Finding the correct level of complexity in interfaces like GLIMPSE is a research challenge.

7.2   Lessons Learned

The use of serious gaming as a strategy for changing behaviors of health professionals is in its infancy. The lessons learned from this project are derived from its most significant challenges. These include:

- Need to identify and focus on a limited number of key learning objectives.
- Typical professional development activities for health professionals tend to be broad and have numerous learning objectives. By nature of the game experience, the number of learning objectives needed to be limited and clearly stated in terms that the developers could understand. When developing a game for health professionals, including a process for curriculum design is essential.
- Importance of knowing the audience. What may seem artistically appropriate or engaging for "gamers" may not be clinically accurate or engaging for health professionals. Although the project plan included time for review, need for extensive dialog between content experts and developers was more than anticipated.
- Knowing the limitations of the technical requirements in advance. For health professionals, use of the game for professional development while on duty is important. When developing games for health professionals, consideration needs to be given to the game technical requirements versus robust firewalls and other technical constraints that may exist in healthcare settings.

7.3   Opportunities for Future Research

This project provides a solid foundation for further research on the use of serious gaming for healthcare professionals. Further research opportunities include: Is serious gaming an efficient and effective learning strategy to change behaviors (beyond acquiring knowledge) of healthcare professionals? What are the characteristics of learners most likely to achieve desired educational outcomes using a gaming strategy? What are the most and least desirable characteristics of a game for this population?

8   Summary

This paper discusses innovative research into interface designs that can take advantage of serious games and other emerging frameworks to enhance physician/nurse communication and improve patient safety. Presented is an eight-point framework that includes: recommended communication behavior; accurate translation; narrative-driven, role-playing episodes that allow practice in different challenging situations; perspective sharing mechanisms; a design paradigm that accommodates time-challenges of participants; motivational gameplay rewards; feedback/assessment mechanisms; and curriculum.

Lessons learned include the need to identify and focus on a limited number of key learning objectives; the importance of knowing the audience; and knowing the limitations of the technical requirements in advance. Opportunities for future research include: Is serious gaming an efficient and effective learning strategy to change behaviors (beyond acquiring knowledge) of health professionals? What are the characteristics of learners most likely to achieve desired educational outcomes using a gaming strategy? What are the most and least desirable characteristics of a game for this population? While GLIMPSE certainly uncovered a variety of unique implementation challenges, the framework presented here provides a solid foundation for further research to develop the promise of serious game for interprofessional communication enhancement for physicians and nurses and other healthcare professionals.

References

1. Dingley, C., Daughterty, K., Derieg, M., Persing, R.: Improving patient safety through provider communication strategy enhancements. In: Henriksen, K., Battles, J.B., Keyes, M.A., Grady, M.L. (eds.) Advances in Patient Safety: New Directions and Alternative Approaches, vol. 3. Agency for Healthcare Research and Quality, Rockville (2008)
2. Susi, T., Johannesson, M., Backlund, P.: Serious Games: An Overview. Institutionen för kommunikation och information, Skövde (2007)
3. Barry Issenberg, S., Mcgaghie, W., Petrusa, E., Lee Gordon, D., Scalese, R.: Features and uses of high-fidelity medical simulations that lead to effective learning: a BEME systematic review. Med. Teach. **27**(1), 10–28 (2005). doi:10.1080/01421590500046924
4. Graafland, M., Schraagen, J., Schijven, M.: Systematic review of serious games for medical education and surgical skills training. Br. J. Surg. **99**(10), 1322–1330 (2012). doi:10.1002/bjs.8819

5. Dekker, Sidney. Just culture: Balancing safety and accountability. Ashgate Publishing, Ltd., 2012

6. Raybourn, E.: designing intercultural agents for multicultural interactions. In: Payr, S., Trappl, R. (eds.) Agent Culture: Human-Agent Interaction in A Multicultural World, 1st edn, pp. 267–285. Lawrence Erlbaum, Mahwah (2008)

7. Kharrazi, H., Faiola, A., Defazio, J.: Healthcare game design: behavioral modeling of serious gaming design for children with chronic diseases. In: Jacko, J.A. (ed.) HCI International 2009, Part IV. LNCS, vol. 5613, pp. 335–344. Springer, Heidelberg (2009)

8. Domínguez, A., de-Navarrete, J.S., de-Marcos, L., Fernández-Sanz, L., Pagés, C., Martínez-Herráiz, J.: Gamifying learning experiences: practical implications and outcomes. Computers & Education, 63, pp. 380–392 (2013). doi:10.1016/j.compedu.2012.12.020

9. Deterding, S., Dixon, D., Khaled, R., Nacke, L.: From game design elements to gamefulness. In: Proceedings of the 15th International Academic MindTrek Conference on Envisioning Future Media Environments - MindTrek 2011 (2011). doi:10.1145/2181037.2181040

10. Fogg, B.: Persuasive Technology. Morgan Kaufmann, Boston (2003)

11. Riesenberg, L., Leitzsch, J., Little, B.: Systematic review of handoff mnemonics literature. Am. J. Med. Qual. **24**(3), 196–204 (2009). doi:10.1177/1062860609332512

12. Staggers, N., Blaz, J.: Research on nursing handoffs for medical and surgical settings: an integrative review. J. Adv. Nurs. **69**(2), 247–262 (2012). doi:10.1111/j.1365-2648.2012.06087.x

13. Randmaa, M., Martensson, G., Swenne, C.L., Engstrom, M.: SBAR improves communication and safety climate and decreases incident reports due to communication errors in an anaesthetic clinic: a prospective intervention study. BMJ Open **4**(1), e004268–e004268 (2014). doi:10.1136/bmjopen-2013-004268

14. Cornell, P., Gervis, M.G., Yates, L., Vardaman, J.M.: Impact of SBAR on nurse shift reports and staff rounding. MEDSURG Nursing **23**(5), 334–342 (2014)

15. Institute for Health Improvement (2011). SBAR Technique for Communicating: A Situational briefing Model. http://www.ihi.org/knowledge/Pages/Tools/SBARTechniqueforCommunicationASituationalBriefingModel.aspx. Accessed 4 March 2015

16. Brown, P., Levinson, S.: Politeness. Cambridge University Press, Cambridge (1987)

17. Pronovost, P.: Acute decompensation after removing a central line: practical approaches to increasing safety in the intensive care unit. Ann. Intern. Med. **140**(12), 1025–1033 (2004). doi:10.7326/0003-4819-140-12-200406150-00013

18. Thomas, E., Sexton, J., Helmreich, R.: Discrepant attitudes about teamwork among critical care nurses and physicians*. Crit. Care Med. **31**(3), 956–959 (2003). doi:10.1097/01.ccm.0000056183.89175.76

19. Fischer, U., Orasanu, J.: Error-Challenging Strategies: Their Role in Preventing and Correcting Errors. Proc. Hum. Factors Ergon. Soc. Ann. Meet. **44**(1), 30–33 (2000). doi:10.1177/154193120004400109

20. Linde, C.: The quantitative study of communicative success: politeness and accidents in aviation discourse. Lang. Soc. **17**(03), 375 (1988). doi:10.1017/s0047404500012951

21. Orasanu, J., Fischer, U., McDonnell, L., et al.: How do flight crews detect and prevent errors? findings from a flight simulation study. Proc. Hum. Factors Ergon. Soc. Ann. Meet. **42**(3), 191–195 (1998). doi:10.1177/154193129804200302

22. Fischer, U.: Cultural Variability In Crew Discourse. Georgia Institute of Technology, Atlanta (2000)