The escape room that saves lives

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Abstract

Crew Resource Management (CRM) has become an important instrument in the training of health care personnel, however, the level of training for the ICU teams could be enhanced. To enhance CRM training several escape room puzzles were designed, and this paper will test one of the escape room puzzles. This paper reports the development and assessment of an evaluation instrument for the nine crucial CRM skills. The nine skills are 1) situational awareness, 2) feedback, 3) cognitive performance under stress, 4) closed loop communication, 5) effective teamwork, 6) use of checklists, 7) leadership and followership, 8) briefing before doing a procedure and lastly 9) effective and structured handover. A learning curve experiment was performed on one of the designed escape room puzzles. The main research question was: "Does the Under Pressure escape room puzzle suitably improve or measure team dynamics?" It was found that puzzle does improve team dynamics in general, however, it should be modified to encourage the skills of feedback, closed loop communication, effective teamwork, and the use of checklists.

Keywords: Crew Resource Management, escape room, situational awareness, feedback, cognitive performance, closed loop communication, teamwork, leadership and followership

Introduction

It is important in a medical environment that the patients are not threatened by the risk of human errors which could be caused by, for example, miscommunication or emotional stress (Haerkins et al., 2012). Especially in intensive care as there may be unintentional harm done to patients. According to a study by Zegers et al. (2009) in 2004 in the Netherlands about 4.1% of all hospital deaths were caused by preventable adverse events, which is between 1482 and 2032 patients. Moreover, the financial costs of these preventable adverse events amounted to about 1% of the hospital's budget (Kievits, 2009).

There is currently a system to provide the patient with the safest possible environment. This system works according to "Crew Resource Management" or "CRM" principles. CRM has its origins in the aviation industry. CRM started when the KLM Boeing 747 crashed into the Pan Am flight 736, which was called the Tenerife disaster. During the investigation of this disaster, it was discovered that human factors contributed to the crash. Human factors such as communication and hierarchy. The solution for this problem was mandatory human factor training for all air personnel. This training, Crew Resource Management, was developed in 1979 (Haerkens et al., 2012). These principles were also applied to medical situations such as the ICU to improve the safe environment for patients. CRM has been associated in health care with a reduction in serious complications and with a lower mortality with critical patients (Haerkens et al., 2015).

Currently, the ICU personnel that are involved with patient care at the Radboudumc must attend a basic 2-day awareness training with a professional CRM training organization called "Wings of Care" (Wings of Care, n.d.), with a refresher course of one day every three years. These principles are regularly used by medical professionals.

The problem however is that while the CRM program of the Radboudumc is one of the Netherlands' CRM reference centres, teamwork is a skill that only occurs infrequently and is difficult or misunderstood (Lerner et al., 2009). Some of the important issues that are hard to teach with CRM are speaking up, giving and receiving feedback, and sharing thoughts. The current practices are still working well, however, a higher level of CRM and thus a safer environment are difficult to reach with the current practices.

It is necessary to enhance the current practices a more advanced and versatile level of training for the ICU teams. One of the solutions was the idea of using an escape room, which is also used to improve teamwork in the Royal Dutch Navy (van Beveren, 2018), furthermore, they are being used as learning environments at all levels of education and even professional development programs (Sanchez & Plumettaz-Sieber, 2019; Veldkamp et al., 2020). Escape rooms have already been used for the improvement of teamwork and leadership skills (Warmelink et al., 2017), and in domains such as nursing, medicine and pharmacy (Adams et al., 2018; Cain, 2019; Cotner et al., 2018; Veldkamp et al., 2020). An escape room allows the team members to cultivate team dynamics, such as communication and splitting tasks, while in a high-stress environment. Escape rooms are also known for helping soft skills grow among learners (Morrell et al., 2020; Morrell & Eukel, 2021), it also helps increase knowledge and it improves teamwork and communication (Eukel et al., 2020; Morrell & Eukel, 2021).

The idea of an escape room originates from the concept of serious gaming. Serious games are games that are designed to help, educate, train, or change behaviour while the users are entertained (Stokes, 2005). Serious gaming itself has been used in multiple fields, such as aviation, education, military, city planning and health care (de Wit-Zuurendonk, & Oei, 2011).

Previously to this paper, two groups attempted to design and create a prototype for the escape room. In this paper, two things will be reused from the results of the previous group. The first is the nine crucial CRM skills that the group had discovered and the second one is one of the games that they have created.

As said during their prototype, they have identified nine crucial CRM skills that the escape room should strengthen. The nine skills are 1) situational awareness, 2) feedback, 3) cognitive performance under stress, 4) closed loop communication, 5) effective teamwork, 6) use of checklists, 7) leadership and followership, 8) briefing before doing a procedure and lastly 9) effective and structured handover. These nine skills will be elaborated on.

Furthermore, the previous group also designed the basic setup of the escape room and the various games that would appear in this escape room. The previous group indicated one game which would improve the most diverse sets of skills. This game was ‘Under Pressure’. Under Pressure is a puzzle game in which the team needs to fix an oxygen tube system which is made from rings and tubes of different sizes. The necessary materials to repair the oxygen system are there but they are in different shapes and sizes. To identify the correct tubes to use the participants need to find the manual and follow it. The manual is stuck away from the puzzle so that one of the participants must communicate with the rest what the instructions are. These games or puzzles were compared to the CRM skills that should be improved in the escape room. This game would slightly improve situational awareness and closed loop communication. It would also strongly improve feedback giving, cognitive performance, effective teamwork, leadership and followership, and the use of checklists.

This leads to the research question of this thesis. The research question is: “Does the Under Pressure escape room puzzle suitably improve or measure team dynamics?”

The thesis itself will consist of literature research and an experiment, which will develop a recommendation. In the introduction, there nine CRM skills are discussed. This part of the thesis is necessary to determine how to properly validate any of the puzzles in the escape room and if they are improving the team dynamics. Thus, a proper method of evaluating the escape room puzzles, an evaluation instrument, will be made. Along with this research, one of the puzzles that the previous group of this project made, will be finished and used for the experiment. The experiment will consist of a team of participants attempting to solve the puzzle, while both the team and the puzzle are evaluated with the previously researched evaluation instrument. The results of this research will determine if the puzzle is effective in improving team dynamics and in which regions the puzzle lacks improvement. This will lead to a recommendation for the future validating measures of the puzzle as well as recommendations for the puzzles on how they could be improved.

Situational awareness

The first skill is situational awareness, or to be more specific, the improvement of situational awareness among team members. Situational awareness can be defined as “‘the

perception of elements of the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Brennan et al., 2020; Schulz et al., 2013) or as "a person's ability to maintain an adequate internal representation of the status of the environment in complex and dynamic domains where there are sudden fluctuations in conditions" (Green et al., 2017).

Situational awareness is important in medical health care since a loss of situational awareness can have a detrimental effect on the patient's health. One example could be tunnel vision, in which the medical team focuses too much on one aspect of the patient's health which could have a negative effect on the patient's overall healthcare (Green et al., 2017). A loss of situational awareness has also been linked with the cause of error and poor performance (Endsley, 1995; Fore & Sculli, 2013; Gugerty, 2017).

Fore & Sculli (2013) describe three defining attributes of situational awareness: perception, comprehension, and projection. Perception is being able to perceive the elements, status, and attributes in an environment. Comprehension is being able to understand the situation based on the synthesis of the perceived elements, status, and attributes. Lastly, projection is the ability to project future actions, such as what would happen if the participant used a blue puzzle piece (Endsley, 1995).

Situational awareness is commonly measured with freeze-probe techniques (Endsley, 1988). These techniques are composed of the Situational Awareness Global Assessment Technique (SAGAT) (Endsley, 1988) and/ or the Situational Awareness (process) Control Room Inventory (SACRI) (Hogg et al., 1995). In a freeze-probe the participants are asked to perform a task in a simulated environment which is stopped suddenly, they are then asked questions about their environment to see how much knowledge they have of their situation. After the task is completed the answer to the questions are compared to the overall correct responses, from this a score is calculated using the SAGAT technique (Zhang et al., 2020). There are also self-report techniques such as the Situational Awareness Rating Technique (SART) (Taylor, 2017) and the Situational Awareness Behavioural Rating Scale (SABARS) (Matthews & Beal, 2002). In SART the participant is asked to rate themselves on different seven-rate scales, on topics such as situation familiarity. SABARS on the other hand is an observer-based rating system, in which the observer rates the situational awareness of the participant (Zhang et al., 2020).

Feedback

The second skill is feedback or the improvement of giving feedback among team members. Feedback can be defined as "Specific information about the comparison between a trainee's observed performance and a standard, given with the intent to improve the trainee's performance." (Van De Ridder et al., 2008).

Feedback has been used to improve the quality of healthcare for decades (Brown et al., 2019). It has been noted that feedback provides clinical performance data to a health professional that they could not accurately access with self-evaluation (Hardavella et al., 2017; Ivers et al., 2014). A false self-evaluation can lead to problems regarding healthcare personnel their assessment of their skills and abilities and thus their performance (Hardavella et al., 2017).

An important part of feedback is how to give and receive feedback properly. One of these methods is debriefing, in which the team assesses what they did well, what challenges they

faced and what they would do differently the next time (Leonard et al., 2004). The feedback given in the debriefing could take several forms. One of these forms is the 'Feedback Sandwich', in which the feedback is layered in the form of positive feedback, negative feedback and ending in positive feedback again (Archer, 2010; Hardavella et al., 2017; Sarkany & Deitte, 2017). Another form is the chronological form of feedback, in which the team will go over the events that happened chronologically (Hardavella et al., 2017). The last form that is the Pendleton model. This model is more focused on the learner. The feedback giver first makes sure that the learner is ready and capable of receiving feedback. Then the learner is asked what they think they did right, which the feedback giver reinforces or adds to. Then, when the learner is comfortable, they themselves can elaborate on what they think could be improved, which the feedback giver dissects and offers opportunities on how to improve their performance (Archer, 2010; Hardavella et al., 2017; Pendleton et al., 2003; Sarkany & Deitte, 2017).

Cognitive performance under stress

The third skill is cognitive performance or the improvement of the cognitive performance of team members under a stress Cognitive performance can be defined as "the performance of the mental processes of perception, learning, memory, understanding, awareness, reasoning, judgment, intuition, and language" (APA Dictionary of Psychology, n.d.). Cognitive performance is associated with mental activities such as perception, thinking, remembering and reasoning (Karsh et al., 2006).

Increased stress can have negative effects on a person's health and job satisfaction (Parry et al., 2018; Patel et al., 2017; Shanafelt et al., 2012; Smith et al., 2017). Stress can also cause many health issues such as burnout, depression, lack of sleep and a poorer quality of life (Parry et al., 2018). Furthermore, high-stress intensity can affect cognitive performance chronically and acutely (Lighthall & Vazquez-Guillamet, 2015). This is especially true for medical personnel as they have to make appropriate decisions under time pressure while dealing with a patient (Lighthall & Vazquez-Guillamet, 2015).

Closed loop communication

The fourth skill is closed loop communication or its improvement among team members. Closed loop communication is a communication model that is based on proper feedback to ensure that the team members have a complete understanding of the message (Salik & Ashurst, 2019). This method is used by first relaying the message, then the second person confirming that the message was received and lastly the original messenger asking again if the message was received. This method has also been called read-backs (Dayton & Henriksen, 2007).

The advantages of this method are that the information in the messages is essential and in the most efficient form. Responsibility for tasks is also enhanced when the information is stated and repeated back. Furthermore, stress is reduced due to an increase in structure and a decrease in uncertainty. The back and forth can also encourage probing and interaction amongst the hierarchy (Dayton & Henriksen, 2007). Poor communication is also one of the most common causes of inadvertent patient harm (Leonard et al., 2004).

Effective teamwork

The fifth skill is the improvement of effective teamwork. Teamwork is classified in healthcare as a continuing process of interactions between team members while they provide care for a patient (Clements et al., 2007).

It is noted that for effective teamwork, collaboration is needed (Clements et al., 2007; Oandasan et al., 2006). Effective teamwork is also characterised by the ability to respond and adapt to changing situations, the team members have faith, trust and positivity in their ability to properly achieve their goal, they produce high-quality results, and they are capable of determining areas which need improvement and able to allocate resources to those areas (Clements et al., 2007; Rosen et al., 2018; Wagner, 2004). Effective teams are also said to establish clear goals, define and assign roles and tasks, train said individuals, resolve internal conflicts, and have clear processes and structures for communication (Grumbach & Bodenheimer, 2004; Rosen et al., 2018; Wagner, 2004).

Effective teamwork is seen as a means to improve productivity and quality for patients, while also supporting a happier and healthier work environment (Clements et al., 2007; Wagner, 2004). It also provides improved partnership and communication and coordination (Kates & Ackerman, 2000; Nolte & Tremblay, 2005).

Usage of checklists

The sixth skill is the improvement of the usage of checklists. Checklists are used to aid memory and decision-making (Kramer & Drews, 2017). The inclusion of checklists has brought many advantages such as improved communication, better compliance with standard procedures, reduced adverse events, and reduced morbidity and mortality (Thomassen et al., 2014).

The usage of a checklist gives a standardized method that could reduce the reliance on memory and reduce errors that were made by omissions (Walker et al., 2012). This could also be beneficial in both the briefing before a procedure and the handover. It could also improve team communications and situational awareness (Bosk et al., 2009; Catchpole et al., 2007).

Leadership and followership

The seventh skill is the leadership and followership skills of the team members. Leadership and followership are defined as "Leader identity as a sub-component of one's working self-concept that includes leadership schemas, leadership experiences and future representations of oneself as a leader. Follower identity is a sub-component of one's working self-concept that includes followership schemas, followership experiences and future representations of oneself as a follower." (Epitropaki et al., 2017). Followership is important in healthcare because a follower can have either a negative or a positive effect on health care depending on whether they feel valued, engaged or see a benefit. While they do not have formal power, they do have knowledge, skills and relationships (Kellerman, 2008; Leung et al., 2018).

Kelley (1992) divides followership into five main categories: passive, conformist, alienated, pragmatist and exemplary. Passive followership is associated with a low degree of critical thinking and engagement. Conformists have a high level of engagement and motivation; however, they have a low level of critical thinking, which makes them more dependent on their leader. Alienated followers are the opposite, they show high levels of critical thinking

and independent thoughts, but they have low levels of engagement and motivation. Pragmatists are capable of both critical thinking and high levels of engagement, but they only act when it is necessary. Exemplary followers are both critical thinkers and have high levels of active engagement (Kelley, 1992; Leung et al., 2018). In healthcare leadership and followership are important in different aspects. The different followership styles do have for example an impact on burnout scores (Crawford & Daniels, 2014). The specific followership styles would be ‘exemplary’ and ‘pragmatist’ which are associated with lower burnout scores. The ‘exemplary’ followership style is associated with job satisfaction, personal accomplishment and organizational performance (Gatti et al., 2017; Jin et al., 2016; Leung et al., 2018; Morgan, 2014).

In healthcare, there are also several different leadership styles. The first is transactional leadership, which is practised widely in healthcare (Kumar, 2013). This leadership style depends on rewards and punishments by a leader with clear authority, this could lead to an improvement in production (Sfantou et al., 2017). The next leadership style is transformational leadership (Burns, 2012; Frandsen, 2014; Kumar, 2013; Sfantou et al., 2017). This leadership style is based on the fact that their followers follow them for their vision, enthusiasm and passion. This results in increased productivity, strengthens employee morale, job satisfaction, and it is also associated with lower patient mortality. Furthermore, transformational leadership is positively related to effectiveness, teamwork success, staff satisfaction and commitment (Burns, 2012; Mah'd Alloubani et al., 2014; Sfantou et al., 2017). Then there is an autocratic leadership style, this style is hierarchical, and the leader makes all of the decisions, which is considered ideal in emergency situations (Sfantou et al., 2017). Laissez-faire leadership is however the opposite, in this style the leader does not make decisions and the other team members act without direction or supervision (Frandsen, 2014; Sfantou et al., 2017). Then there is task-oriented leadership, this style is more about the planning of work activities, such as the assignment and clarification of roles, setting objectives, and monitoring the process. Lastly, there is the relationship-oriented leadership style, this style is about support, recognition and development. The last two styles are associated with higher patient satisfaction (Sfantou et al., 2017; Yukl, 1981).

One of the problems with leadership is that there could be a power distance between leaders and followers according to hierarchy, this discourages the followers from speaking up properly (Leonard et al., 2004). The ability to question and challenge others and oneself has been seen as an important part of active followership (Whitlock, 2013). Hierarchy itself can damage effective teamwork structures (Clements et al., 2007). Team leader inclusiveness can also help overcome negative effects such as low psychological safety (Rosen et al., 2018).

The measurement of leadership is diverse, but there are several techniques that researchers use. Such as the group performance and the success of group goals (Madanchian et al., 2017). Several models help in training leadership in health care. One of these models is the Healthcare Leadership Model (Kumar & Khiljee, 2016; NHS Leadership Academy, 2013).

Briefing before a procedure

The eighth skill is the promotion of performing a briefing before a procedure. Briefings before a procedure are important for a proper common understanding of the upcoming situation for all the responsible participants. A common understanding is important since it could be that there is a new member of the team, or an entirely unfamiliar team,

which could mean a different mode of operation or assigned duties and responsibilities is needed. It also allows asking for clarifications and addressing concerns (Dayton & Henrikson, 2007; Lingard et al., 2004; Makary et al., 2006).

Proper briefings before doing a procedure have several advantages for health care. Nundy et al. (2008) have found that having a briefing before performing a procedure reduces unexpected delays and that there is a reduction of delays caused by a communication breakdown. Nundy et al. (2008) indicate that briefings increase efficiency, improve care quality and reduce costs. Makary et al. (2007) also found that briefings reduced the perceived risk of wrong-site surgery and improved the collaboration between OR personnel.

One of the briefing methods is the SBAR (Leonard et al., 2004), which stands for situation, background, assessment and recommendation. The situation is for what is happening to the patient, the background is for the clinical background of the patient and the context, the assessment is for what the most likely cause of the problem is and the recommendation is for the suggested solution to correct the problem. This method could improve the performance of medical personnel (Kesten, 2011). In nurse-to-doctor communications, it could also reduce errors and give more conciseness to communications (Hohenhaus et al., 2006; Vardaman et al., 2012).

Other important parts of the briefing are the introduction of the team members and how they operate. Then the critical information is shared about the situation, using for example SBAR, but also what the contingencies and the potential risks are. Furthermore, it needs to be confirmed that all the necessary equipment and devices are available (Dayton & Henrikson, 2007; Lingard et al., 2004; Makary et al., 2006). This entire process could be done with for example a checklist.

Effective and structured handover

The last skill is effective and structured handover. A handover is a transfer of professional accountability and responsibility for some or all aspects of a patient's care to another professional, which is either temporary or permanent (Merten et al., 2017). This skill is important because a poor handover can cause unnecessary delays, patients not receiving the required care, and medication errors (Australian Commission on Safety and Quality in Health Care, 2011; Merten et al., 2017).

One of the methods for an effective and structured handover is also the SBAR method and a checklist method (Dunn et al., 2007; Leonard et al., 2004). This could prevent confusion and medical errors in the handover process, improve communication and improve efficiency (Catchpole et al., 2007; Hohenhaus et al., 2006).

An example of the handover procedure was devised by Catchpole et al. (2007) This procedure has three phases. The first phase is the equipment and technology handover and making sure that the patient is properly situated. The second phase is the information handover in which all the relevant information is given to the next team. A checklist and the SBAR method could be used for this phase. The third phase is the discussion and plan phase, in which the medical personnel discuss what the plan of action is going to be. This procedure reduced errors, the handover time, and it improved information transfer. A handover also needs to follow the criteria of being accurate, timely, unambiguous, complete, and understandable to the recipient (Merten et al., 2017).

The nine CRM skills in Under Pressure

To once again reiterate the nine CRM skills, they can be found in table 1 with a definition and an example.

Table 1
The nine CRM skills with definitions and examples.

The CRM skill	Definition	Example
Situational awareness	The perception of elements of the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future.	The ability to spot all of the loose tiles in a game of Jenga and decide on further steps.
Feedback	Specific information about the comparison between a trainee's observed performance and a standard, given with the intent to improve the trainee's performance.	Saying what was nice and what was bad about a movie.
Cognitive performance under stress	The performance of the mental processes of perception, learning, memory, understanding, awareness, reasoning, judgment, intuition, and language.	The ability to perform a memory game.
Closed loop communication	Closed loop communication is used by first relaying the message, then the second person confirming that the message was received and lastly the original messenger asking again if the message was received.	"Today we are having pasta." "Pasta?" "Yes."
Effective teamwork	Teamwork is classified in healthcare as a continuing process of interactions between team members while they provide care for a patient.	The ability to quickly solve a team puzzle.
Use of checklists	The use of checklists is the actual usage of checklists.	Using a shopping list.
Leadership and followership	Leader identity as a sub-component of one's working self-concept that includes leadership schemas, leadership experiences and	

	future representations of oneself as a leader. Follower identity as a sub-component of one's working self-concept that includes followership schemas, followership experiences and future representations of oneself as a follower.	
Briefing before doing a procedure	A briefing before doing a procedure is the performing of a briefing before a procedure.	Deciding a team strategy before paintballing.
Effective and structured handover	A handover is the transfer of professional accountability and responsibility for some or all aspects of a patient's care to another professional, which is either temporary or permanent.	Letting another person take over the cooking and explaining what is being cooked, how long it needs to cook and how long it is already cooking.

These nine CRM skills interact with each other when a team is working together. For example, a checklist can be used in the briefing before a procedure, but also in the handover. Leadership and followership are deeply intertwined with effective teamwork. Situational awareness is important in cognitive performance and briefing before a procedure also needs leadership and followership. These skills are expected to show up in Under Pressure as designed by the former group. As said before, the expectation was that the game would slightly improve situational awareness and closed loop communication. It would also strongly improve feedback giving, cognitive performance, effective teamwork, leadership and followership, and the use of checklists. The use of a manual in the puzzle could improve the use of checklists since they can use it to reduce the errors they could make (Walker et al., 2012). Situational awareness and closed loop communication can be slightly improved because the team is using a checklist (Bosk et al., 2009; Catchpole et al., 2007). Feedback needs to be given to the leader to make sure that they are giving the right instructions and the right strategy (Hardavella et al., 2017). To solve the puzzle in general there needs to be effective teamwork, and leadership and followership. Lastly, cognitive performance under stress should increase because the puzzle describes a stressful situation, and the participants need to think logically and make appropriate decisions (Lighthall & Vazquez-Guillamet, 2015). The results of this research will determine if the puzzle is effective in improving team dynamics and in which regions the puzzle lacks improvement.

Methodology

Participants

In total there were 15 participants, all of them were University of Twente students aged between 18 and 27, 9 were female and 6 were males. The experiment was performed

with students as the experiment focuses more on the skills that could be gathered from the puzzle, for which no medical background was necessary. The participants were gathered in 4 groups of 3 to 6 people to simulate the normal working groups in a medical environment and escape rooms. This also prevents free-riding and creates more participation (Cain, 2019; Veldkamp et al., 2020). The participants were recruited using SONA credits from the University of Twente, which the students could gather if they were to participate in the experiment.

Materials

The materials used in this experiment were a camera, the Under Pressure puzzle, and a specifically designed evaluation paper.

The Under Pressure puzzle

The puzzle involved a broken oxygen system in a submarine (Figure 1). This oxygen system consisted of an oxygen tank, a valve, and a pipe system with connection pieces (Figures 1, 2, and 3). The goal of the puzzle was to fix the broken pipes and either the oxygen tank or the valve.

Figure 1

The Puzzle Set-up.

Figure 2

The Inside of the Oxygen Tank, with a Broken Oxygen Pipe.

Figure 3

The Valve.

Figure 4

The Puzzle Materials.

To achieve this goal, there was a checklist available with instruction on how to fix the pipe. There were 4 different versions of the instruction's manual, with also 4 different solutions (see Appendix A). The entire puzzle was made of either carton, paper or thick paper. The pipes were made of paper and had letters on the side to further clarify the size if there was uncertainty. A broken pipe or piece gained a lightning bolt or zigzag pattern in black marker on the side (Figure 4), as actually damaging the object could cause the object to tear from use or rough handling.

The evaluation instrument

The evaluation instrument (see Appendix B) was made with the information gathered about the nine CRM skills. The nine skills are 1) situational awareness, 2) feedback, 3) cognitive performance under stress, 4) closed loop communication, 5) effective teamwork, 6) use of checklists, 7) leadership and followership, 8) briefing before doing a procedure and lastly 9) effective and structured handover. This evaluation instrument was combined with observation. The observed behaviour of a group was written down underneath one of the nine skills by the observer. All of the numerical questions were answered with the number of instances of the behaviour or the time stamp of the first time the behaviour occurred.

For the first skill, situational awareness, it was remarked that perception, comprehension and projection were the three defining aspects of situational awareness (Fore & Sculli, 2013). This is the basis for questions 1.1 - 1.3. As said before, perception is the ability to perceive the elements, status and attributes in the environment, this leads to question 1.1 as the general question. To be more specific for the Under Pressure puzzle questions 1.1.1 to 1.1.6. Comprehension is observed be when the situation is understood in relation to all of the found elements, attributes and statuses, this leads to question 1.2. Questions 1.3 and 1.3.1 were based on the projection aspect of situational awareness, and covered when the participant is able predict how the puzzle should be solved. The second skill, feedback, covers questions 2.1 to 2.6. These questions are based on the literature from Leonard et al. (2004), Hardavella et al. (2017), Archer (2010), Pendleton et al. (2003), and Sarkany & Deitte (2017). As they stated that feedback needs to discuss what went well, what went wrong, what difficulties they faced, how they were going to adapt and the different types of feedback. Cognitive

performance under stress, the third skill, is covered by questions 3.1 to 3.3. As Karsh et al. (2006) explained that cognitive performance covers the areas of perception, thinking, remembering and reasoning. The fourth skill, closed loop communication, is covered by question 4., which simply asks how many times closed loop communication was used. The fifth skill, effective teamwork, is covered by questions 5.1 to 5.6. As Clements et al. (2007), Rosen et al. (2018), Wagner (2004), and Grumbach & Bodenheimer (2004) proclaimed, effective teamwork needs to have clear goals, established roles, solutions to internal conflicts, clear communication, good collaboration, and it needs to produce high-quality outcomes. The sixth skill, the use of checklists, is measured in questions 6.1 to 6.3. This is measured by the actual use of the checklist, but also if they have read the checklist carefully or made a mistake in the checklist. The seventh skill, leadership and followership, is measured in questions 7.1 to 7.3. 7.1 and 7.2 are based on followership, in the sense that followership is measured by critical thinking and active engagement (Kelley, 1992; Leung et al., 2018). 7.3 is a leadership question and tries to identify the different leadership styles that were used, in accordance with Burns (2012), Frandsen (2014), Kumar (2013), Mah'd Alloubani et al. (2014), Sfantou et al. (2017), and Yukl (1981). The eighth skill, briefing before a procedure, is measured in accordance with the literature of Dayton & Henrikson (2007), Leonard et al. (2004), Lingard et al. (2004), and Makary et al. (2006). This literature suggest that a briefing must have an introduction of all the participants, that they discuss a plan, that there is an opportunity to ask questions or raise concerns. The questions also try to identify if the SBAR method or a checklist was used. The last skill is effective and structured handover. Catchpole et al. (2007), Dunn et al. (2007), Leonard et al. (2004), and Merten et al. (2017) state that a handover needs to be accurate, timely, unambiguous, complete, and understandable. As well that there needs to be an equipment handover, an information handover, a plan discussion, and if the SBAR method was used or a checklist.

Procedure

On the day of the experiment, the participants were asked to come in a group of 3 to 5 participants to 4 sessions in a classroom at the university. There were 4 groups across different days. The 4 sessions took place on the same day, and a session was between 5 to 15 minutes long with small recesses of 5 minutes in between. In the classroom, there would be a puzzle laid out across the room. The participants would first be asked to fill out the consent form and if they agree to be filmed during the experiment. The participants were then asked to solve the puzzle, involving the broken pipe system. The participants were informed of the setting, which is a submarine where the oxygen tube system is broken, and it needed to be fixed as fast as possible. The main tube system was placed at the centre of the room, and the instruction manual at the far side of the room. The pipes of different colours and sizes were scattered across the room. The participants needed to find out what part of the system is broken and relay this to the instruction reader, who then needed to relay the correct instructions for solving the problem. The problem was that the pipes were broken and that either the valve was broken, or the oxygen tank was empty. The participants first needed to fix either the oxygen tank or the valve. The other participants then needed to find the correct pipes, which were scattered across the room, and insert the right pipes in the right positions. The timer stopped when the puzzle was solved. The next time the participants were asked to solve the puzzle again, for which the instructions had been slightly changed, as well as the pipes that were broken.

Data processing and analysis

The first step was a literature analysis of the nine skills to make an evaluation instrument. This was done using Google Scholar. Subsequently, the puzzle was made and all of the papers concerning it. The filmed video recordings of all the groups performing the puzzle were transcribed and made anonymous on the same day of the experiment (see Appendix D). The transcriptions were then examined for the nine CRM skills as well as how long it took the participants to solve the puzzle. The evaluation instrument forms (see Appendix E) were then compared to each other for each group and each trial to see if there was any improvement made in the nine skills. The independent variables were the trial sessions and the groups the participants were in. The dependent variables were the nine skills. The comparisons would be made across group types and trial sessions. Most of the nine skills had qualitative measures and were analysed if the behaviour had occurred and how it presented itself, this was then compared to the optimal behaviour found in the literature analysis. The statistical analysis consisted of learning curve line plots. The numerical values were either time stamps of the first occurrence of a certain behaviour in seconds or the number of instances a behaviour occurred. These include for example the amount of time needed to find all the broken pipes or the number of times closed loop communication was used. The numerical values gained in the analysis were put into excel, where they were subsequently used in R to make line graphs (see Appendix C).

Results

The transcriptions and evaluation instrument papers of all the trials can be found in appendix D and E respectively.

Situational awareness

For the first skill, situational awareness, the perception was measured in seconds. As you can see in Figures 5 and 6, the first time it took the longest to find the broken pipes and the broken valve or oxygen tank, after which this searching time declined. There were exceptions for groups 1 and 4 as the time needed to find the broken pipes increased in the last trial. Group 3 also took longer to find the broken pipes in trial 3 in comparison to trial 2. Figure 7 shows the time it took to find the checklist, but there is no recognizable pattern. Figure 8 shows how quickly the teams found all the hidden objects. Group 4 managed to find all the objects the first 3 times. None of the other groups managed to find all the objects. The comprehension could however not be measured, since the participants did not give a sign for when they understood the connection between all the pieces. For projection, it was measured how long it took to solve the puzzle, in figure 9 you can see that there was a steady decline in time, with the only exception being group 3 in trial 3 and group 1 in trial 4.

Figure 5

The Seconds It Took to Find the Broken Pipes for Each Group and Trial.

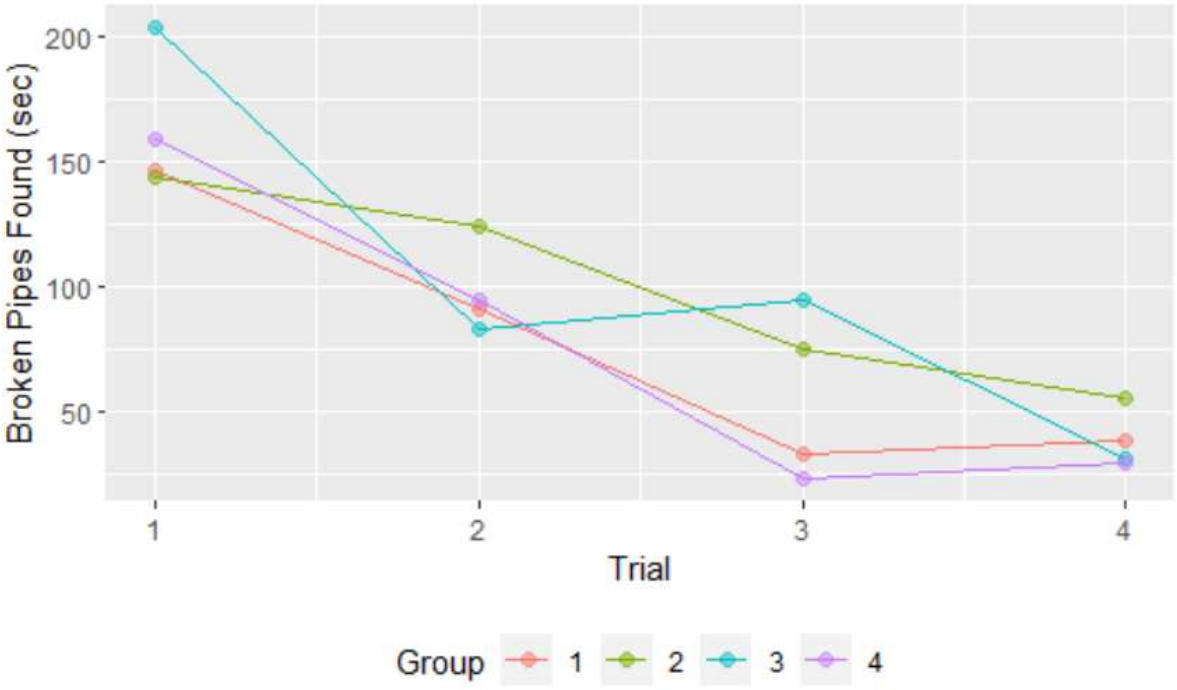
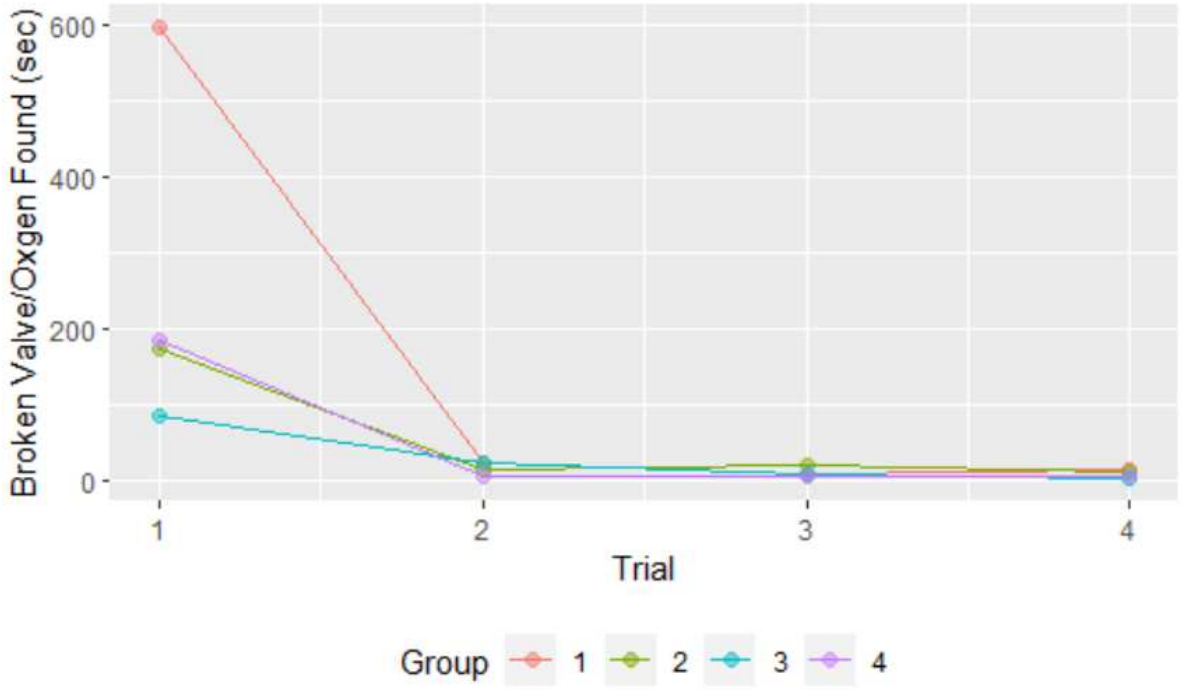


Figure 6

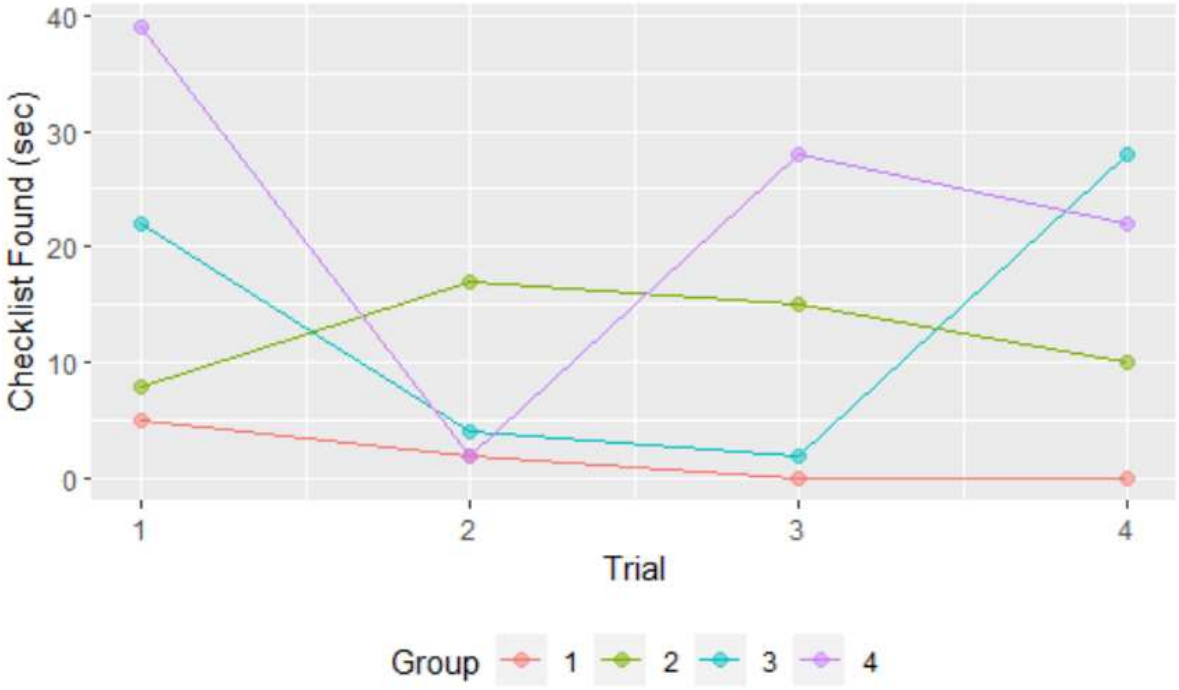
The Seconds It Took to Find Either the Broken Valve or the Broken Oxygen Pipe for Each Group and Trial.



Note: The trials that overlapped have a blended coloured dot.

Figure 7

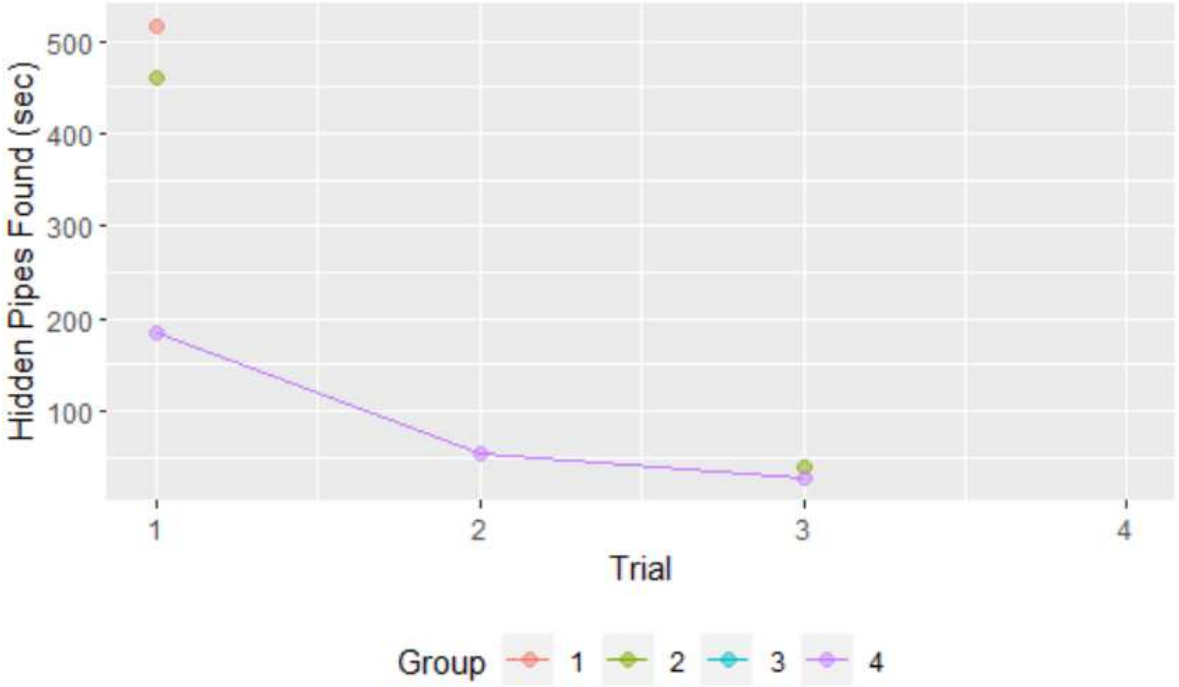
The Seconds It Took to Find the Checklist for Each Group and Trial.



Note: The trials that overlapped have a blended coloured dot.

Figure 8

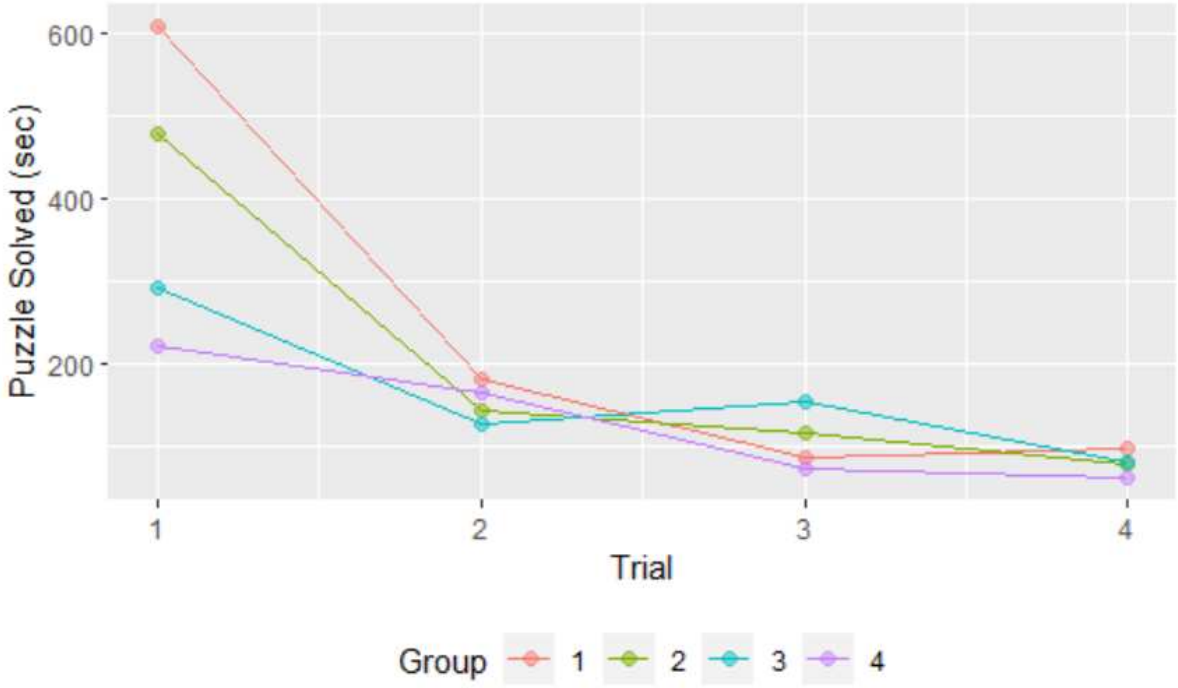
The Seconds It Took to Find All the Hidden Objects for Each Group and Trial.



Note: The trials in which they did not find all the hidden objects were excluded.

Figure 9

The Seconds It Took to Solve the Puzzle for Each Group and Trial.



Note: The trials that overlapped have a blended coloured dot.

Feedback

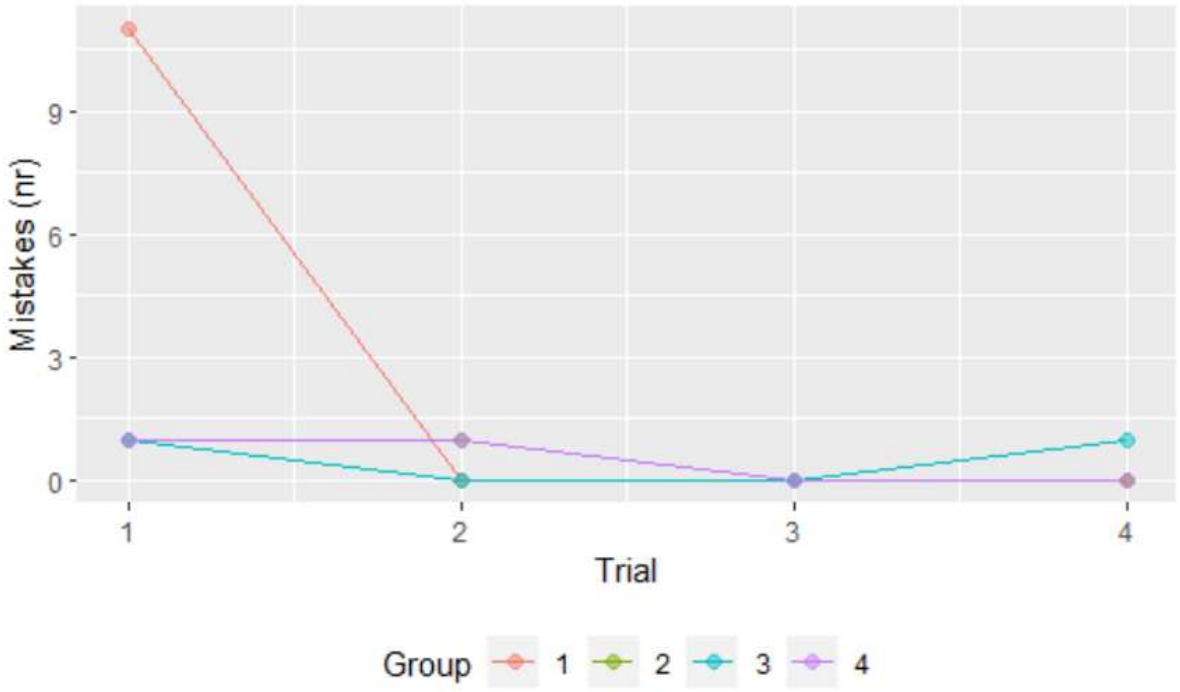
The second skill of feedback gave the results that none of the groups used feedback in the experiment, and the participants did not show any signs of giving feedback. Thus, the number of times feedback was used and what methods of feedback were used, could not be measured.

Cognitive performance under stress

In the third skill it could be seen in general that the time of solving the puzzle went down with each trial, with two exceptions (figure 9). The number of mistakes made in the experiment can be seen in figure 10. In general, the number of mistakes went down with each instance, but there was one exception in trial 3-4. One of the parts of cognitive performance is perception. The perception part of the experiment has already been analysed and is the same as the perception part of situational awareness (figures 5-8).

Figure 10

The Number of Mistakes Made for Each Group and Trial.



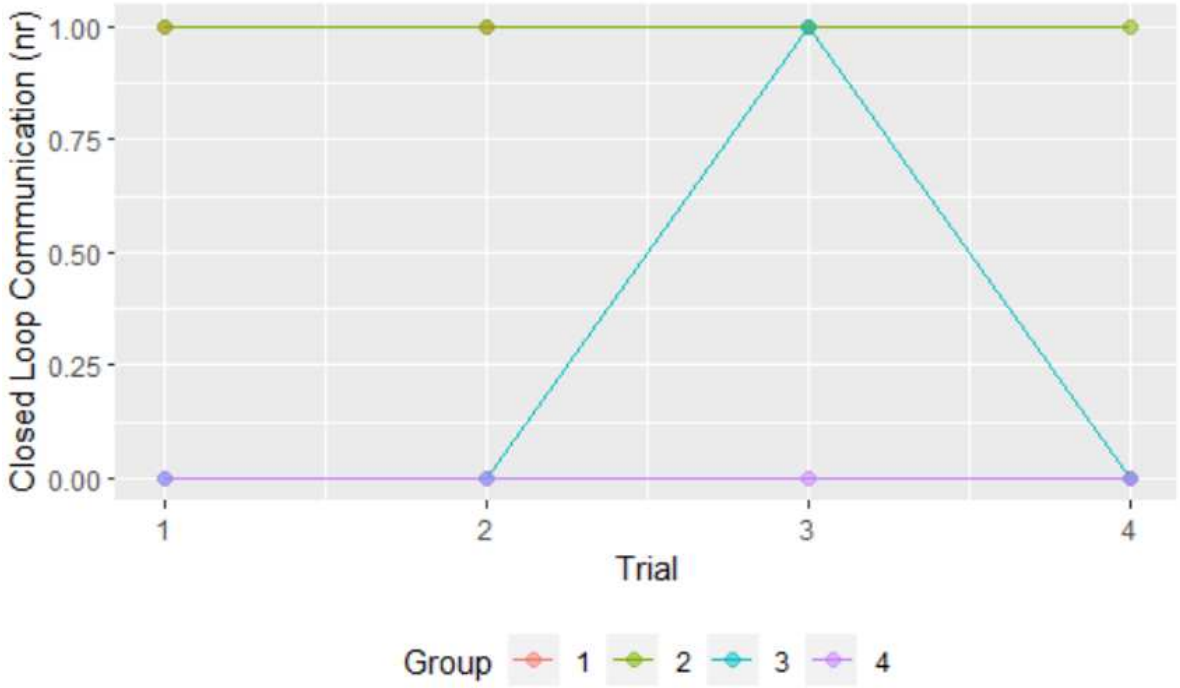
Note: The trials that overlapped have a blended coloured dot.

Closed loop communication

The fourth skill of closed loop communication was either only used once or not at all, with no large fluctuations. This can be seen in figure 11, the groups either used it once in each of the trials or did not use it for all of the trials, with the exception being group 3, who used it once in trial 3 and group 1, who did not use it in the last trial.

Figure 11

The Number of Times Closed Loop Communication Was Used for Each Group and Trial.



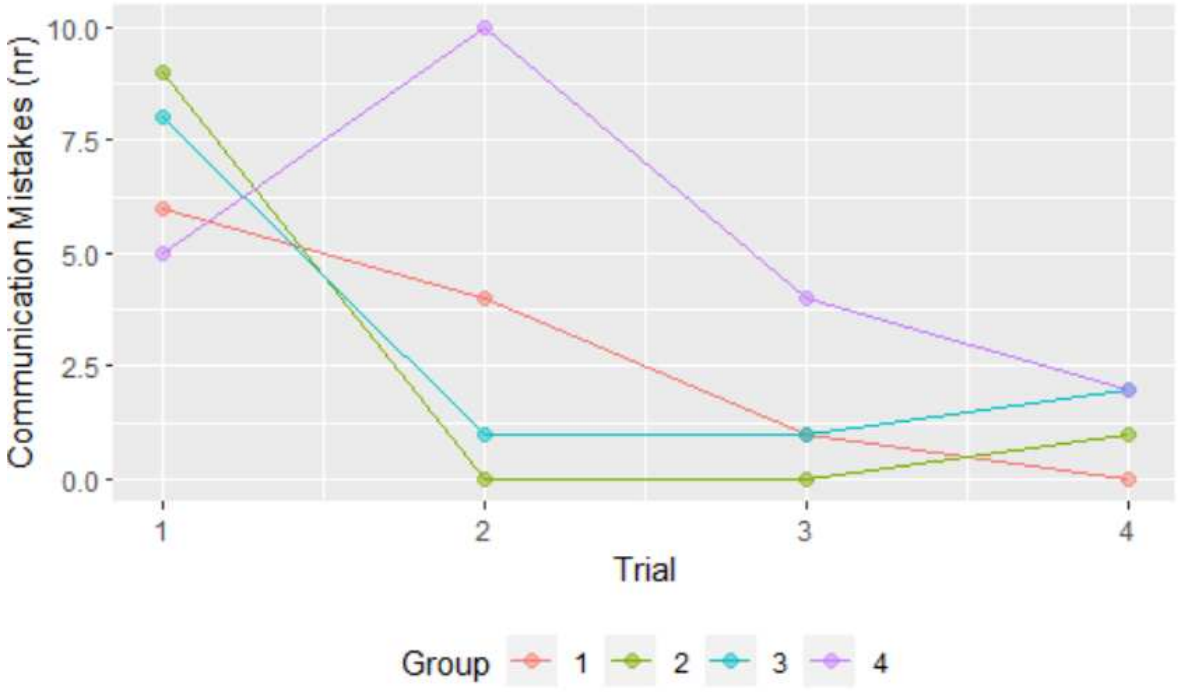
Note: The trials that overlapped have a blended coloured dot.

Effective teamwork

The fifth skill of effective teamwork showed that the time needed to finish the puzzle was indeed going down, except for group-trials 1-4 and 3-3 (Figure 9). It was also found that in general, the teams did not establish a clear goal during the experiment, except for group-trial 1-4. Moreover, there was no internal conflict found, except in group-trial 1-2. Mistakes in communication however were more common (Figure 12), the most common ones were mumbling and talking over each other, this also decreased with the repeating of the trials. The exception is group 4 who made a large number of mistakes in the second trial and groups 2 and 3 who made a few more mistakes in the last trial. In general, there were no special comments regarding the handover of objects. The proper division of labour was, however, mostly the same for each of the groups. It should be noted that group 1 had a problem with the division of labour in the first trial and switched the leader twice. Groups 2 and 3 had a problem establishing a leader in the beginning. Also, in the cases of groups 2 and 4, there were people with more loose roles and sometimes did not actively participate in the experiment.

Figure 12

The Number of Times There Was a Communication Mistake for Each Group and Trial.



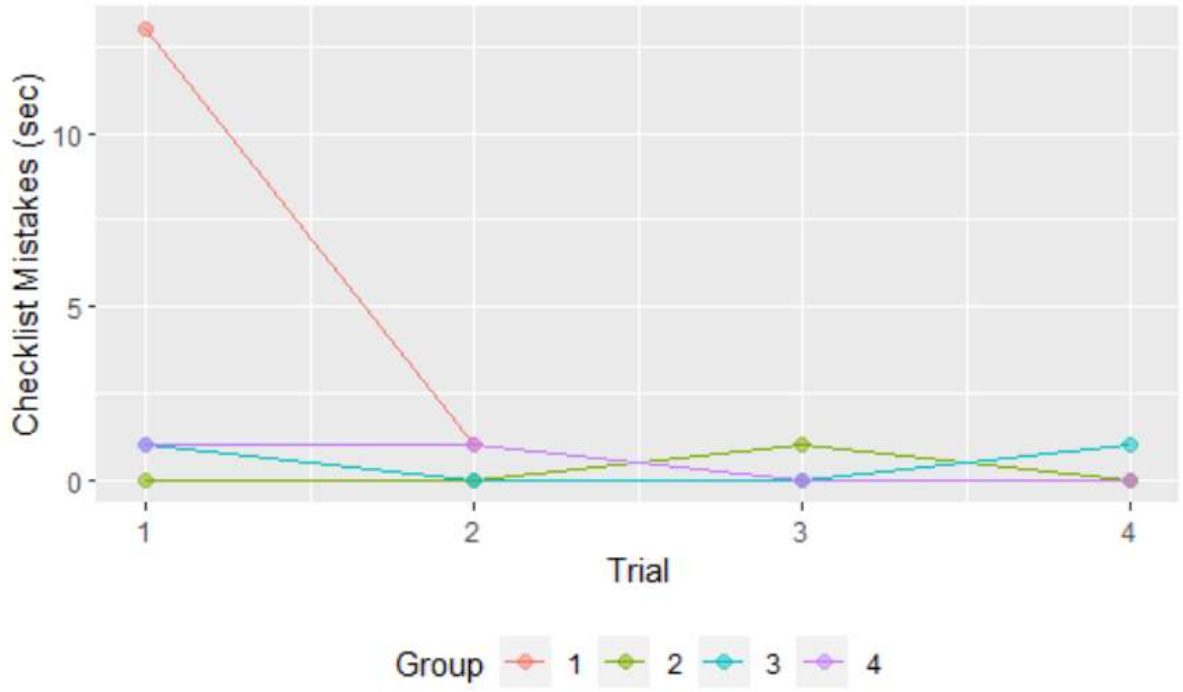
Note: The trials that overlapped have a blended coloured dot.

The use of checklists

The sixth skill was the use of checklists. In each instance of the experiment the participants used the checklist. It was however clear that only in the first trial the participants read the entire checklist, in later trials it was unknown, or the participants only picked up the checklist at a later point and thus did not read it completely beforehand. The mistakes made with the checklist were numerous in the first trial, however, in later trials, this did decrease, with a few variable instances. This can be seen in figure 13, group 2 briefly make a mistake in trial 3 and group 3 makes a mistake in trial 4.

Figure 13

The Number of Times a Mistake Was Made Using the Checklist for Each Group and Trial.



Note: The trials that overlapped have a blended coloured dot.

Leadership and followership

The seventh skill was leadership and followership. For group 1 the followers were in the first trial searching for solutions and proposed plans of action, this was further amplified by the initiative shown. The followers switched positions with the leader when they did not understand the experiment, they also switched positions when needed. The leadership style was in the beginning transformational, task-oriented and relationship-oriented, because the leader joined in the searching for hidden objects, made sure what the steps that should be taken were and kept an eye on their followers and supported them. In the second trial, the followers took initiative when the instruction went wrong and they suggested solutions, they also once again divided themselves properly over the tasks. The leadership styles that were used, were task oriented and relationship oriented. The leader directly showed a plan for them but made sure to regularly check in on the followers and the leader was willing to take suggestions. In the third trial, the followers still showed initiative and critical thinking, but more in the sense that they went automatically searching for hidden objects. The leadership was once again task-oriented, and relationship-oriented for the same reasons as the second task. In the fourth trial, the followers began to show more initiative as they immediately began searching, but they also switched positions so that the other follower could search, and they began helping each other. The leadership changed to transformational, task-oriented, and relationship-oriented, since the leader began helping the followers search, read the instructions for them, was willing to listen to their suggestions and made sure to regularly check in on the followers.

For the second group, in the first trial, the followers did propose solutions and began searching for pipes or handing over pipes to the leader. The leadership style however was a mix of transformational, autocratic, laissez-faire and task-oriented leadership. In the

beginning, there was no leader, and the decisions were made by the group when a leader was chosen, this leader made all of the decisions and the followers followed. In the end, the leader also began helping in the search for pipes and made a plan for the instructions. In the second trial, the followers presented alternative solutions and took the initiative to search for objects and present a team division. The leadership style had turned into task-oriented leadership. The leader mainly followed the plan laid out by the checklist and the followers had their own tasks. In the third trial, the followers gave indications of what went wrong and voluntarily went searching for objects or a new post when they were done. The leadership style became a mix of transformational and task oriented. Since the checklist was still followed, and the leader checked in with the followers, the leader was also willing to listen to them and help in the puzzle process. In the fourth trial, the followers acted similarly to the third trial. The leadership style had shifted towards transformational, and relationship oriented, as the leader began listening to his followers, addressed their concerns and helped actively with solving the puzzle.

The third group had no followership style in the first trial, mainly because the leadership style was entirely laissez-faire. There was no general leadership and thus no general followership. In the second trial, the followers began to show initiative and went searching around the room on their own. The leadership style became task-oriented since they followed the plan from the checklist. In the third trial, the followers began making suggestions for where the pipes were hidden and began searching voluntarily. The leadership style also became transformational, as the leader willingly helped with searching while directing the followers. In the fourth trial, the followers once again willingly searched the room and the leadership style was transformational, for the same reason as in the third trial.

The fourth group had followers in the first trial, that had suggestions on how to fix the oxygen system and which pipes to use, moreover they had the initiative to begin searching on their own. The leadership style was transformational, since the leader lead by example and took suggestions from the followers. The second trial also had followers that thought critically, as they proposed solutions and made a system for the found objects. They also carefully analysed their mistakes on their own, along with the initiative to begin searching on their own. The leadership style was once again transformational. Due to similar reasons and the fact that the leader carefully listened to the followers. In the third trial, the followers went searching voluntarily and the leadership style was once again transformational for similar reasons. In the last trial, the followership style and the leadership style were the same as the last trial.

Briefing before a procedure and effective and structured handover

For the eighth skill of briefing before a procedure, only group 4 briefly discussed what the plan and their goal was in the first trial. The ninth skill of effective and structured handover was not used.

Discussion

The results show that, through the multiple trials, the participants get better at the Under Pressure puzzle. Most of the results show a downwards trend in time for each trial or a positive improvement with each trial. There were however several exceptions to this downward trend and several unexpected occurrences such as the fact that no feedback was

given, almost no closed loop communication was used, the reading of the checklists was not always done, and the problems with labour division and the choosing of the leader. This could cause problems in the teams' effectiveness. As the choosing of a leader, the giving of feedback, and the reading of the checklists are important in healthcare.

This discussion will first discuss the most important exceptions that the results have shown, then it will discuss the strengths and weaknesses of this research. After that, the reasons for the results will be discussed, the relevance and implications of these results, with at the end the conclusion.

The most important exceptions in the results are the CRM skills of giving feedback, closed loop communication, effective teamwork, using checklists and leadership and followership.

As said in the results, the different groups gave no feedback in any of the trials, which is somewhat congruent with the findings in the paper of Archer (2010), Hardavella et al. (2017), Pendleton et al. (2003), and Sarkany & Deitte (2017), since they stated that giving feedback takes time.

The fourth skill was closed loop communication. Figure 11 showed the number of times closed loop communication was used and it showed that closed loop communication was used once in each trial for one group, or it was never used, just once or one time not. Which is in line with the research of Diaz & Dawson (2020), whose participants did not use closed loop communication before being trained in it.

The fifth skill was effective teamwork. Once again figure 9 shows how much time it costs to finish the puzzle, a time which was indeed going down with each trial, with a few exceptions. There was no internal conflict outside of one instance, however, the mistakes made in communication were more visible. In general, the number of mistakes went down with each trial. There were no special comments seen in the handover of objects. There was however improvement shown in the aspect of labour division. All the groups with the exception of group 4 had problems with establishing a leader and a proper task division. In later instances the tasks of were more properly divided. This is in line with the article of Tarricone & Luca (2002).

The sixth skill was the use of checklists. It was found that the number of mistakes made in the use of the checklist decreased with the number of trials, with two exceptions. With the exception of one group, the number of mistakes did not significantly change with each trial. The checklist was also used each time. However, it was observed that in later instances, the checklists were not read entirely anymore, or it was unknown if the participant read the entire checklist.

Followership has been mostly stable across all of the trials, with the exception being when there was no clear or autocratic leadership. In general, the followers took a lot of initiative in solving the puzzle and when the opportunity arose, they showed critical thinking ability. This did not significantly change over the different trials. The leadership style mainly affected the initiative and critical thinking the followers would exhibit. The leadership style took a lot of different forms across the four groups, but in general the leadership style changed to transformational, task-oriented and/or relationship-oriented. According to Kelley (1992) and Leung et al. (2018), the most desired followership styles have active engagement and critical thinking among the followers. The most desired leadership style was, according to Burns

(2012), Frandsen (2014), Kumar (2013), Mah'd Alloubani et al. (2014), Sfantou et al. (2017), and Yukl (1981), the transformational leadership style, since that style increases productivity, strengthens morale, job satisfaction, effectiveness, and commitment. The task-oriented and relationship-oriented leadership styles are also associated with higher patient satisfaction.

This experiment had several strengths and weaknesses. One of the strengths is that this research took a qualitative approach to the experiment. Due to which it was possible to directly observe the behaviour of the participants while they were solving the Under Pressure puzzle. This approach also made it easier to find mistakes in the design of the puzzle and the design of the experiment, which would give more areas for future improvement.

One of the main weaknesses in this experiment was task learning. The participants began to learn how to solve the puzzle instead of improving their team dynamics. This was partially mitigated by changing the instruction manual for each trial, however, it should be taken into account that it could be a confounding factor in the results.

There were also weaknesses within the design of the puzzle. As could be seen in figure 4, the broken pipes had a black lightning or zigzag pattern to convey that the pipe was broken. This method did not work as the participants were confused about what was broken. Thus, in later groups the participants were informed what a broken pipe or object looked like. If the experiment were to be repeated, there should be a better solution to convey that the object is broken, for example, the object could be actually broken or have cuts in it. There was one other problem with the puzzle, which was the checklist. The broken pipes section of the checklist (see Appendix A) included a table, however, it was not made clear enough that they were in fact two separate tables. One for the pipe size and one for the forbidden colours. This led to the problem that the participants thought that for example between A and B there could not be the colour pink, instead of that the colour pink could not be connected to connection piece A. Thus, in this experiment the improper use of the forbidden colours was not counted against the participants. To prevent this from happening again is for example that the actual puzzle will not connect to puzzle pieces of the incorrect colour or size. The checklist can also be changed to keep the two tables more separately.

Another weakness is with the evaluation instrument. A problem with the mistake measure was that the severity of the mistakes was not taken into account, actual mistakes have the same weight as things such as mumbling. This however should have no effect on the results, though it may have made them more extensive. A further weakness came in the form of the participants. Due to a difficulty in gathering participants, only 15 participants could participate in the experiment. This influences the robustness of the results. And since it is a small group of participants the results cannot be generalized.

One of the problems with the experiment was the speech of the participants. The participants often mumbled or talked over each other. It could be possible that the other participants understood everything perfectly, however it is also possible that it could not be captured by the filming equipment. To prevent this from happening again, the instructions could be even more clear or there should be better filming equipment. The checklist location was another problem in the experiment. The checklist was located in the same room as the puzzle and not entirely separate from the puzzle. This subsequently meant that the person at the checklist could easily walk back and forth between the checklist and the puzzle. This had an influence on the leadership styles that were used, since it was possible for the leaders to directly assist

the other team members. One of the weaknesses was the stress level during the experiment. The stress during the puzzle was relatively low, due to the fact that it was a puzzle, there was no actual time pressure and there were no distractions in the environment that could induce stress. Stress could however be simulated with for example a timer that is counting down, flashing lights or a beeping sound (Hancock & Szalma, 2003). Another limitation was the number of participants. When there were more than three participants the extra participants were often left with nothing to do when the searching part of the experiment was finished. The experiment was originally designed for 4 to 6 participants; however, this experiment shows that that may not be true. This is not a problem in an actual escape room, since the participants could switch to working on the main puzzle instead of on Under Pressure.

The results could be explained with several different reasons. One of the results was that the time to find the checklist did not always decrease. This might be due to the participants not needing to find the checklist immediately anymore and thus they could wait to find the checklist. It could also be explained that the participants had already found the checklist but saw no need to acknowledge it or physically go to the checklist. The results for the unfound, hidden objects might be due that often, the participants missed pipes that were laying around and thus the time it took them to find all of the hidden objects could not be measured. The participants often did not need to search for the remaining objects, since they were not needed to solve the puzzle, one group only searched for the object they needed and left the rest of the objects hidden, which made it difficult to count if the objects were found or not. The comprehension part of situational awareness could not be measured in this context, since, after the first trial, the participants would already comprehend the entire situation and how the objects are linked together. Moreover, it was not possible to observe when exactly they comprehended the situation. The same could be said for the projection part of situational awareness. It was not possible to observe exactly when the participants were able to predict the solution, the only measure that could have been taken was the time it took to finish puzzle. This could be solved with a think aloud experiment.

Furthermore, the groups did not use closed loop communication a lot. Most of the time, the groups only used it once or not at all. This could be due to the effect that there was no general procedure or briefing before the start of the puzzle. In normal CRM training, these skills and methods are explained for the participants (Gross et al., 2019).

Another result was that there were no formal leadership positions and thus it was up to the participants themselves to decide upon a leader which caused problems for three of the groups. Clear leadership helps with the communication of clear goals and the task distribution (Endedijk et al., 2018). For the leadership styles, the exception was group 4, which could be explained with the prior relationship the participants had with each other before the experiment and therefore already having a team dynamic. It is possible to speculate on the impact the lack of having a leader had in the first trial. It could be seen in effective teamwork. The labour division improved when a leader was chosen, and the followers switched positions and tasks less. Appropriate team composition, and leadership was also one of the essential qualities for a successful team (Tarricone & Luca, 2002).

The Under Pressure puzzle was not meant to encourage a briefing before a procedure or a handover after a procedure. It would be possible to speculate that this had an impact on the use of feedback, goal establishment and the use of checklists. None of the groups gave

feedback to each other. This could be due to the difficulty people have in giving feedback, the time that is available, the reluctance and fear of retribution in giving negative feedback, and the belief that feedback does not actually change behaviour (Thomas & Arnold, 2011; Vorvick et al., 2008). In the Pendleton model, the feedback giver is making time so that the learner feels comfortable and slowly they go through the feedback (Archer, 2010; Hardavella et al., 2017; Pendleton et al., 2003; Sarkany & Deitte, 2017). The attitude toward feedback also matters. Feedback givers could be reluctant to give feedback due to the heightened emotions the feedback provokes, such as anger, guilt, pride, and sadness (Thomas & Arnold, 2011). All these factors could impede the feedback giving especially in a situation where time is of essence. As such a specific time such as a handover or a briefing before or after a procedure could encourage feedback giving. It could also be possible that feedback was given, but the participants did this during the break, and it could not be recorded. A clear goal was also not established during the experiment; however, this could be due to the fact that solving the puzzle was already a clear goal. Establishing a clear goal could however have been done in a briefing before a procedure. One of the peculiarities of the checklists was that in later instances the checklists were not entirely read anymore, or it was unknown it the participant read the entire checklist. This could be due to the completion time necessary to complete the entire checklist, it is known that less people will want to use a checklist if it is time consuming (Verdaasdonk et al., 2009).

From this research there are several points that need to be raised and their relevance and impact discussed. The first is the results we got from the closed loop communication. As said in the introduction, closed loop communication is important as the responsibility for tasks is also enhanced, the stress is reduced, and the back and forth can encourage probing and interaction amongst the hierarchy (Dayton & Henriksen, 2007). Poor communication is also one of the most common causes of inadvertent patient harm (Leonard et al., 2004). In the experiment the participants did not use it a lot, even though the puzzle encouraged closed loop communication. This would indicate that it is important to teach and encourage closed loop communication.

Another important point is that in the beginning, there was no clear leadership in the groups, unless the participants were familiar with each other, and it took the group time to find a preferable leadership style and adjust to it. This adjustment period could be dangerous in a healthcare setting. It has also been said that the most preferred leadership style according to Burns (2012), Frandsen (2014), Kumar (2013), Mah'd Alloubani et al. (2014), Sfantou et al. (2017), and Yukl (1981) was the transformational leadership style, since that style increases productivity and strengthens morale, job satisfaction, effectiveness, and commitment. This time period in which there is a need to discuss leadership and the labour division could be included in the next point, which was the briefing before the procedure. As pointed out before, a briefing before a procedure could help in the goal establishment and the use of checklists. Since a briefing could form a proper common understanding of the upcoming situation for all the responsible participants and it gives the opportunity to ask for clarifications and to address concerns (Dayton & Henrikson, 2007; Lingard et al., 2004; Makary et al., 2006). This process could thus help with goal establishment.

Another relevant point was the lack of given feedback. Feedback is important, as it provides clinical performance data to a health professional, which they could not accurately access with self-evaluation (Hardavella et al., 2017; Ivers et al., 2014). A false self-evaluation could

lead to problems regarding people their assessment of their skills and abilities and thus in their performance (Hardavella et al., 2017). The giving and receiving of feedback is therefore important, but feedback is not given, if it is not encouraged or given the time. This could lead to the before mentioned problems, which makes it important to encourage the receiving and giving of feedback. This could be done by simply giving the participants a moment to give and take feedback.

There are several recommendations for following research. One of the recommendations is regarding the comprehension and projection part of situational awareness. These two could be measured in an experiment where the participant is asked to think aloud, which would be recommended. The research can also be continued by evaluating other puzzles with the same evaluation instrument, that will be adjusted to the specific paper. The experiment could also be modified by giving the group one leadership style with which they need to complete the puzzle, so that the effect of the leadership style on the other nine CRM skills could be compared. Furthermore, the experiment could be modified by assigning one of the participants to be the leader. Another possible experiment would be performing the experiment with medical personnel instead of with students, since students are in a different age bracket and most of them have no medical knowledge.

In conclusion, to answer the research question, which was "Does the Under Pressure escape room puzzle suitably improve or measure team dynamics?", the puzzle does work. The participants show improvement with the Under Pressure puzzle, but it is important that it is modified to encourage more of the nine CRM skills. The puzzle should be modified in a way that there is an opportunity for a briefing before the experiment and time after the experiment for feedback. It is also important that before the participants enter the escape room, that they are fully briefed on the CRM skills and on how to use them.

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Appendix A

Instructions Experiment

Instruction manual in case of oxygen failure – Trial 1

Step 1 - **determine cause**

If oxygen tank is empty go to step 2

If pipes are broken go to step 3

If the valve is broken go to step 4

Step 2 – **oxygen tank is empty**

2.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

2.2 - Replace the oxygen tank

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

2.3 - Open the valve

Step 3 - **pipes are broken**

3.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

3.2 - Replace the pipe with a matching pipe of the correct size

Connection Piece	Pipe Size		Connection Piece	Forbidden Colors
Between A and B	Large		A	Pink
Between B and C	Small		B	Green
Between C and D	Medium		C	Yellow
Between D and A	Small		D	Pink

3.3 - Open the valve

Step 4 – **The valve is broken**

THE ESCAPEROOM THAT SAVES LIVES

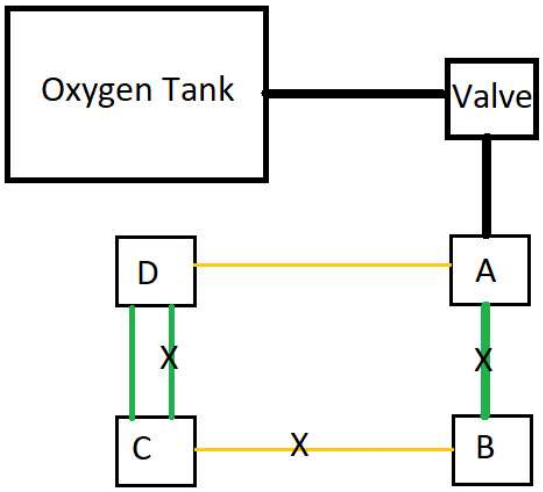
4.1 - Replace the valve

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

4.2 - Open the valve

THE ESCAPEROOM THAT SAVES LIVES

Beginning



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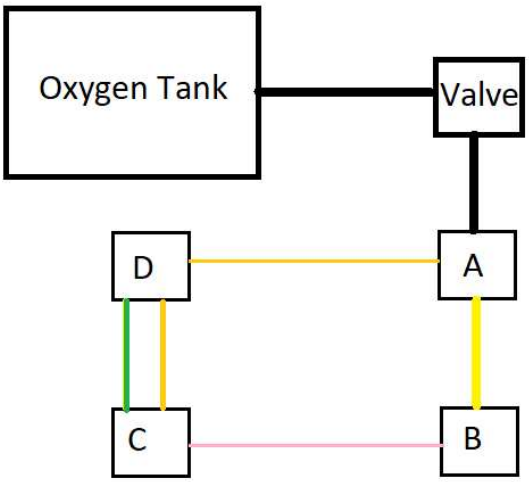


THE ESCAPEROOM THAT SAVES LIVES

Instruction manual in case of oxygen failure – Trial 2

Step 1 - **determine cause**

If oxygen tank is empty go to step 2

If pipes are broken go to step 3

If the valve is broken go to step 4

Step 2 – **oxygen tank is empty**

2.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

2.2 - Replace the oxygen tank

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

2.3 - Open the valve

Step 3 - **pipes are broken**

3.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

3.2 - Replace the pipe with a matching pipe of the correct size

Connection Piece	Pipe Size		Connection Piece	Forbidden Colors
Between A and B	Medium		A	Pink
Between B and C	Large		B	Green
Between C and D	Small, Medium		C	Yellow
Between D and A	Large		D	Pink

3.3 - Open the valve

Step 4 – **The valve is broken**

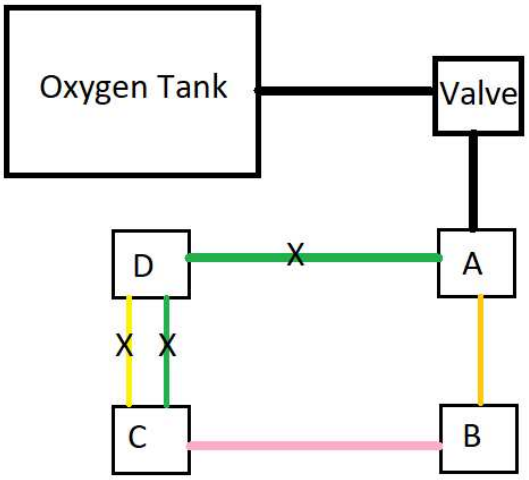
4.1 - Replace the valve

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

4.2 - Open the valve

THE ESCAPEROOM THAT SAVES LIVES

Beginning



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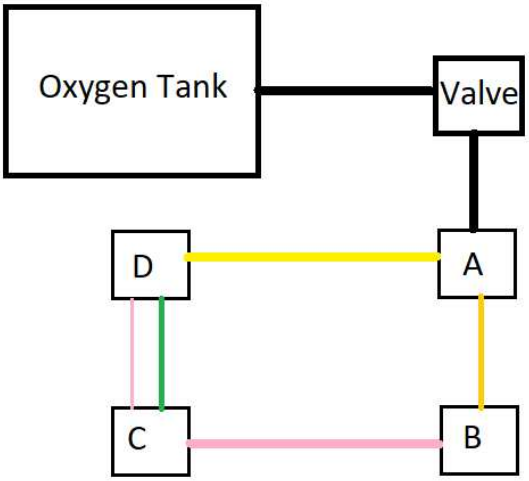


THE ESCAPEROOM THAT SAVES LIVES

Instruction manual in case of oxygen failure – Trial 3

Step 1 - **determine cause**

If oxygen tank is empty go to step 2

If pipes are broken go to step 3

If the valve is broken go to step 4

Step 2 – **oxygen tank is empty**

2.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

2.2 - Replace the oxygen tank

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

2.3 - Open the valve

Step 3 - **pipes are broken**

3.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

3.2 - Replace the pipe with a matching pipe of the correct size

Connection Piece	Pipe Size		Connection Piece	Forbidden Colors
Between A and B	Small		A	Pink
Between B and C	Medium		B	Yellow
Between C and D	Large, Small		C	Orange
Between D and A	Medium		D	Green

3.3 - Open the valve

Step 4 – **The valve is broken**

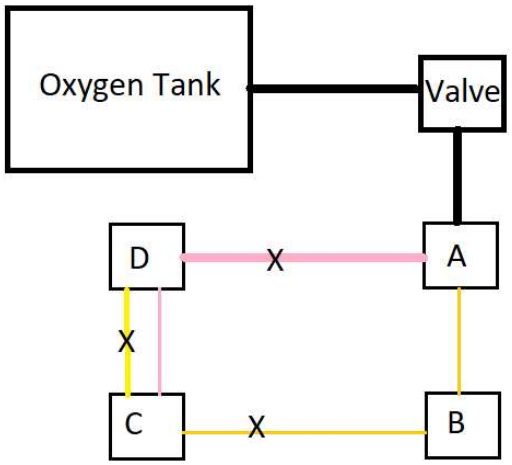
4.1 - Replace the valve

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

4.2 - Open the valve

THE ESCAPEROOM THAT SAVES LIVES

Beginning



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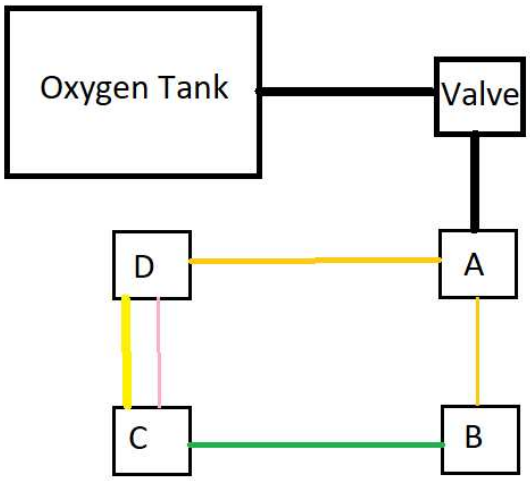


THE ESCAPEROOM THAT SAVES LIVES

Instruction manual in case of oxygen failure – Trial 4

Step 1 - **determine cause**

If oxygen tank is empty go to step 2

If pipes are broken go to step 3

If the valve is broken go to step 4

Step 2 – **oxygen tank is empty**

2.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

2.2 - Replace the oxygen tank

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

2.3 - Open the valve

Step 3 - **pipes are broken**

3.1 - Close the valve

WARNING: IF THE VALVE IS BROKEN, FIRST FIX THE VALVE!

3.2 - Replace the pipe with a matching pipe of the correct size

Connection Piece	Pipe Size		Connection Piece	Forbidden Colors
Between A and B	Medium		A	Orange
Between B and C	Small		B	Yellow
Between C and D	Medium, Large		C	Green
Between D and A	Large		D	Orange

3.3 - Open the valve

Step 4 – **The valve is broken**

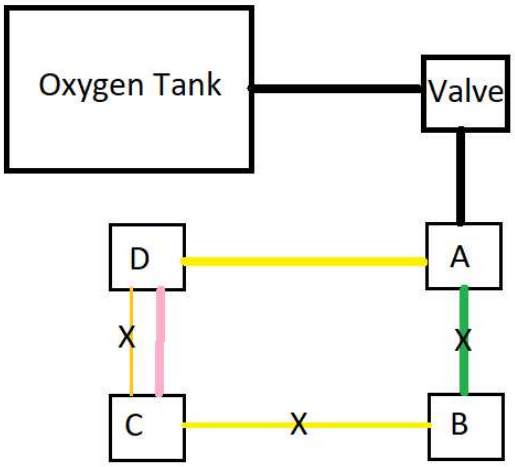
4.1 - Replace the valve

WARNING: IF THERE ARE BROKEN PIPES, DO NOT OPEN VALVE UNTIL THE PIPES ARE FIXED!

4.2 - Open the valve

THE ESCAPEROOM THAT SAVES LIVES

Beginning



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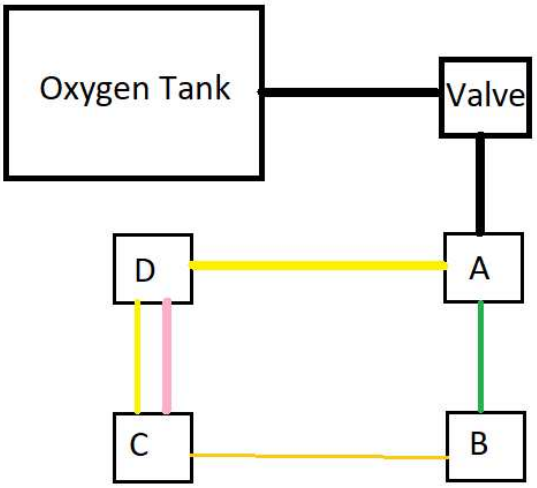

Appendix B

Evaluation Instrument

1. Situational awareness
    - 1.1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        - 1.1.1. The time needed to find the broken pipes
        - 1.1.2. The time needed to find the broken valve
        - 1.1.3. The time needed to find the broken oxygen tube
        - 1.1.4. The time needed to find the checklist
        - 1.1.5. The time needed to find all the pipes
        - 1.1.6. The number of objects not found
    - 1.2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    - 1.3. When were the participants able to project the correct solution for the puzzle?
        - 1.3.1. When was the solution to the puzzle found?
2. Feedback
    - 2.1. Did the team discuss what went well?
    - 2.2. Did the team discuss what went wrong?
    - 2.3. Did the team discuss what difficulties they faced?
    - 2.4. Did the team discuss what could be improved?
    - 2.5. Did the team discuss what steps could be taken to improve?
    - 2.6. What feedback model was used
        - 2.6.1. Feedback sandwich
        - 2.6.2. Chronological feedback
        - 2.6.3. Pendleton method
        - 2.6.4. Other/ informal feedback
3. Cognitive performance under stress
    - 3.1. The time needed to finish the puzzle
    - 3.2. The number of mistakes made
    - 3.3. When were all the elements, statuses and attributes perceived in the puzzle environment?
        - 3.3.1. The time needed to find the broken pipes
        - 3.3.2. The time needed to find the broken valve
        - 3.3.3. The time needed to find the broken oxygen tube
        - 3.3.4. The time needed to find the checklist
        - 3.3.5. The time needed to find all the pipes
        - 3.3.6. The number of objects not found
4. Closed loop communication
    - 4.1. The number of times closed loop communication was used
5. Effective teamwork
    - 5.1. The time needed to finish the puzzle
    - 5.2. Did the team establish a clear goal?
    - 5.3. Were there any internal conflicts?
    - 5.4. Did the team make mistakes while communicating with each other?
    - 5.5. Was there an effective handover of objects?
    - 5.6. Was there a proper division of labor?
6. Use of checklists

6.1. Was the checklist followed?
6.2. Was the checklist followed in its entirety?
6.3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

7. Leadership and followership
    7.1. Did the followers use critical thinking?
        7.1.1. Did the followers propose solution or alternative solutions?
    7.2. Did the followers show initiative while solving the puzzle?
    7.3. What leadership style was used?
        7.3.1. Did the leader punish or reward his followers? (Transactional leadership)
        7.3.2. Did the leader make the team members follow them by example? (Transformational leadership)
        7.3.3. Did the leader make all of the decisions? (Autocratic leadership)
        7.3.4. Did the leader make no decisions? (Laissez-faire leadership)
        7.3.5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
        7.3.6. Did the leader mainly support the team members? (Relationship-oriented leadership)
8. Briefing before doing a procedure
    8.1. Did the team have a briefing before they started the experiment?
    8.2. Did the team members introduce themselves?
    8.3. Did the team discuss a method or plan of engagement?
    8.4. Were there any questions or clarification asked?
    8.5. Were there any concerns discussed?
    8.6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
    8.7. Was a checklist used?
9. Effective and structured handover
    9.1. Was the SBAR method used?
    9.2. Were all the necessary materials handed over?
    9.3. Was all the necessary information given to the following team?
    9.4. Was a checklist used?
    9.5. Did the handover team discuss a plan?
    9.6. Was the handover accurate?
    9.7. Was the handover timely?
    9.8. Was the handover complete?
    9.9. Was the handover understandable?
    9.10. Was the handover unambiguous?

Appendix C

R-code for Statistical Analysis

```
library(readxl)
Masterthesis_numbers <- read_excel("University/master/Masterthesis numbers.xlsx")
View(Masterthesis_numbers)

library(dbplyr)
library(tidyverse)
library(openxlsx)
library(rstanarm)
library(gridExtra)
library(devtools)
library(knitr)
library(mascutils)
library(bayr)

DS <- Masterthesis_numbers

DS$Group <- as.character(DS$Group)

```{r}
DS %>%
  ggplot(aes(x = Test, y = broken_pipes, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Broken Pipes Found (sec)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = broken_valve, color = Group, ylim = c())) +
```
```

```
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Broken Valve Found (sec)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = broken_oxy, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Broken Oxygen Found (sec)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = broken_valvoxy, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Broken Valve/Oxgen Found (sec)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = found_checklist, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Checklist Found (sec)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = found_pipes, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
```

```
  labs(y = "Hidden Pipes Found (sec)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = solved, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Puzzle Solved (sec)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = mistakes, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Mistakes (nr)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = loop_comm, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Closed Loop Communication (nr)", x = "Trial") +
  theme(legend.position = "bottom")

DS %>%
  ggplot(aes(x = Test, y = comm_mistakes, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Communication Mistakes (nr)", x = "Trial") +
  theme(legend.position = "bottom")
```

```
DS %>%
  ggplot(aes(x = Test, y = check_mistakes, color = Group, ylim = c())) +
  geom_line() +
  geom_point(alpha = .5, size = 2) +
  labs(y = "Checklist Mistakes (sec)", x = "Trial") +
  theme(legend.position = "bottom")
```

Appendix D

Transcriptions Experiment

Transcription group 1

3 – F

Trial 1-1

1. A – Let's see the instructions first
2. [All move toward checklist] 00.05
3. A – [mumbling instruction]
4. B – We should 2 and a clause first
5. A – Is the oxygen empty?
6. [B and C move towards the puzzle, B opens the oxygen]
7. B – No, there is something here [Moves tubes around]
8. A – Okay if that is not broken, close the main
9. C – What is broken?
10. A – If the pipes are broken?
11. B – No
12. A – What are the pipes
13. C – I think these things
14. B – No I don't think so
15. C – yeah
16. A – Okay
17. B – I guess the valve is broken
18. A – The valve is broken, okay, Close the valve, warning if the valve is broken first fix the valve
19. B – I mean it is..
20. C – So basically we should like that and close
21. A – Okay next, replace the oxygen tank, warning if there are broken pipes do not open the valve until the pipes are fixed
22. B – Replace the oxygen, ah because [Reaches for oxygen] it is not connected
23. A – Yeah you must connect it.
24. {Researcher intervention}
25. A – Okay soo
26. C – Okay so this one is broken [Moves hand towards broken pipe]
27. A – Yeah, so the valve is broken
28. B – [removes another pipe] This one is broken
29. C – yeah
30. A – Replace the button
31. B – and this one as well, okay soso
32. C – Oh yeah
33. [Both B and C replace pipes with random unbroken ones]
34. A – Uuuh
35. B, C – Okay yeah,
36. A – and then, open valve
37. [B moves to open valve, buzzer sounds]

38. C – Somethings wrong with it
39. [B and C look towards A]
40. A – Okay there are broken pipes, do not open the valve until the pipes are fixed, I think there [walks towards the puzzle] is one
41. C – I think there is this one
42. B – Ah this one as well
43. [All hands move towards pipe, C picks up a pipe] 02:27
44. A – Make that this ones
45. C – yeah
46. A – and, these are the pipes, pipe here as well
47. [The pipes are being moved around]
48. [A moves back towards the checklist]
49. A – Up here, .. Okay I think we fixed it, open the valve now
50. [C moves to open up valve, but buzzer sounds]
51. B – Noo
52. C – What is there else
53. A – Okay yeah, so there, the valve was broken, so close the valve warning if the valve was broken fix the valve, no
54. B – No
55. C – I think we fixed everything, like I don't know what it is
56. C – Okay so basically then we didn't
57. B – Okay maybe let me look at that
58. [B moves toward the checklist and A moves toward the puzzle]
59. B – Let me read it
60. A – [A near puzzle] so these are the broken ones
61. C – yeah these are the broken ones, and these ones are extra
62. B – What is pipes?
63. C – This thing
64. B – Okay and valve?
65. [A and C point toward valve]
66. B – okay ,sorry, Is it really broken no?
67. A – it is looking fine
68. {Researcher intervention- if have zigzag pattern it is broken}
69. B – There is nothing there
70. C – yeah
71. A – Is that a zigzag?
72. {Intervention}
73. B – So close the valve, mumbling, Oh, can we take this {Nope}
74. B – Okay maybe we didn't connect it right, because it says for example, between A and B there should be a large one
75. [A points towards pipe A-B]
76. C – Yeah
77. A – It is a large one
78. B – Between B and C small, green
79. A – [Picks up a broken pipe]
80. B – this one is broken so maybe we should take this one, maybe there [Talking over each other]
81. [C is beginning to look around]

82. C – There is stuff on the floor, because these ones are major
83. [A and C begin to look actively, B joins in but stays near checklist, they look]
84. A – There is one here
85. C – There is a yellow
86. B – I personally don't see anything
87. [More looking around the room]
88. A – Is there one with the colour green, large or medium
89. B – They say green small [moved back toward checklist]
90. C – Yeah but we have
91. B – Between b and C
92. [More looking around]
93. B – I mean there is purple one small
94. B – Nope
95. A – This is medium
96. B – Yeah this one is medium, but it should look like this [holds up a pipe] basically
97. A – soo, which one should go where
98. B – Okay, yeah let's just connect another one, between C and D should be medium yellow
99. [A and C are near puzzle again and B is back to the checklist,
100. C – Okay this one
101. [A moves the pipes]
102. A – Okay
103. C – Okay but there is two between C and D
104. B – eeh
105. A – Should the medium be here or here
106. B – oh, one of them was correct before and also there is between D and A small pink
107. C – Small pink
108. B – yes
109. C – oh this one
110. A – between D and A
111. B – D and A, small pink
112. C – That one should be medium green yeah
113. B – and we still have the B and C small green
114. C – ones where?
115. [Begin looking around again]
116. A – B and C
117. B – Between B and C small and green one [C mumbles in between - But this one is]
118. C – Yeah, but I think it still counts as broken [A holds up a pipe]
119. B – It is also medium
120. C – Yeah there should be like a small one
121. [They look around intensively]
122. A – It likes it is in a visible place and we just don't see it
123. C – We are going around, this one is broken
124. A – yeah and broken
125. A – Wait, there is this thing and I am thinking
126. {researcher warns that they need to read the checklist carefully}
127. B – Wait
128. [B and C read checklist]
129. C – Umm, close the valve, mumble mumble

130. C – Forbidden colors, so basically these are the colors we shouldn't have
131. B – Ah yah
132. A – Wait oooh
133. [Talking over each other]
134. C – Between A and B there should be a large pipe, but it should not be pink
135. [B and A are near the puzzle]
136. B – Okay so, it it is also broken even
137. A – Yea
138. C – So it shouldn't be a pink one
139. B – So it should be different colors, okay
140. [Talking over each other and picking up different pipes]
141. C – That one is also broken
142. {Researcher intervention- points out last pipe, A and B pick it up} - 08:36
143. A – This one is
144. B – Yeah yeah
145. [A places yellow one correctly]
146. C – Um okay, between B and C there should be a small pipe but it should not be pink
147. B – This one is good
148. C – And then between C and D there should be a medium pipe and it shouldn't be yellow
149. B – Shouldn't be yellow, so this one
150. A – mumbles something
151. B – before we out how to do that
152. C – and then the last one, between B and A there should be a small pipe and it should not be pink
153. B – Between B and C, what color
154. C – Between B and C it shouldn't be green
155. B – We can change this one then yes
156. B – That is it we can open it now
157. C – yeah we can open it now
158. {Buzzer sound. Advice to check oxygen} 09:58
159. A – It is not empty yea,
160. B – but we checked it
161. A – Maybe because of this
162. B – Ooh
163. [Talk over each other]
164. A and B – That's it [Open valve] [10:09]

Missed objects – 0, intervention needed

Trial 1-2

1. C – Okay instruction
2. A – They are here [finds the checklist] 00:02
3. B – Ah, oh yea
4. A – Step one, determine the cause, if oxygen is empty go to step 1

5. B – It is not empty, but let me just check [checks the oxygen]
6. B – yeah it is okay
7. A – if pipes are broken go to step 3
8. [talking over each other]
9. B and C – Pipes and the valve [00:22]
10. C – So we should first fix the valve
11. A – No it is the pipes, [mumbling], if oxygen tank is empty go to step 3, [mumbling], close the valve
12. C – The valve is broken, we can't close it
13. A – okay [A lot of talking over each other, person B moves towards the checklist]
14. B – Look here, if the valve is broken first fix the valve, yeah and then after the pipes
15. C – Well it is here, we should fix it
16. B – yeah we should [moved back toward the puzzle]
17. [C fixes the valve]
18. B – is that it for the valve?
19. A – if there are broken pipes, do not open the valve until the pipes are fixed
20. C – So now we can close [closes the valve]
21. C – uuh, what are the requirements for fixing
22. A – The pipes?
23. C – [agreement sound] [broken pipes found 1:31]
24. [Person B goes looking for all of the pipes]
25. A – So close the valve and replace the pipe with a matching pipe of the correct size
26. A – Between A and B
27. C – yeah
28. A – [mumbling, is not broken]
29. C – Between B and C which color should it be and which size?
30. A – It should be medium and it should not be pink
31. C – Between B and C?
32. A – Between A and B
33. C – No, what about B and C
34. A – It should be large and not green
35. C – okay, and then C and D
36. [Person C is fixing the pipes and person B is still searching]
37. A – It should be small or medium and the forbidden colors are yellow
38. C – Small or medium right?
39. A – yeah
40. [B is not standing next to the puzzle]
41. C – Okay and then A and D
42. A – eeh, large and the forbidden colours are pink
43. C – okay
44. [B is assisting in putting the puzzle back together]
45. B – That's it?
46. A – A and B is medium?
47. C – Yes it is medium
48. A – and it is not big right?
49. B – [disagreement sound]
50. A – then it is fine
51. B – So we can open the valve?

52. C – So we are finished
53. [03:01]

Missed objects – 2

Trial 1-3

1. Checklist found 00.00
2. C – Okay so first check if the oxygen is empty
3. B – It is not empty, but this one is broken 00.07
4. C – Okay so we need to fix that.
5. [person C is at the checklist, person B at the puzzle, person A is looking for pieces]
6. B – yeah, alright [A handed B the piece]
7. B – okay oxygen tank is clear, yeah only one
8. C – Alright, uuh, are there other parts broken
9. B – yes the pipes are broken, put we should first close the valve [closes the valve]
10. C – Yeah the valve is not broken right?
11. B – So what I see broken is and this one as well, [00.33], okay so we
12. C – Okay, between A and B there should be a small pipe and it should not be pink
13. B – small pipe not pink, yes
14. C – yeah
15. C – between B and C there should be a medium pipe and it should not be yellow
16. [person A joined the puzzle]
17. A – This one?
18. B – That one, yes [A handed green pipe to B]
19. A – Okay
20. C – um between C and D it could be large and small and should not be orange
21. B – So it would be yellow, and a small one not orange
22. [person A looks for right pipe]
23. C – But that one is not orange
24. A – yeah, this one is orange
25. C – [did not wait for others to finish] Between D and A it should be medium and it should not be green
26. B – Die?
27. C – medium and not green, oh there is the yellow one
28. A – yeah
29. B – Is nothing new
30. C – no I think that is it, just close the valve
31. B – Then we're done [01.27]

Missed objects – 2

Trial 1-4

1. [Checklist immediately found]
2. [B at the checklist, C and A at the puzzle]
3. B – Okay
4. C – So oxygen tank is empty, no it is fine
5. A – But the valve is broken so we need to [00.14]
6. B – First we need to fix the valve [C looks for replacement valve]
7. C – This one
8. C – yeah
9. B – Then close it, after that we have pipes [A is looking for pipes]
10. A – yup
11. C – This taking we away [broken pipes away 00.38]
12. B – Okay between A and B it should be medium, not orange
13. A – medium not orange
14. [They all look for pieces]
15. C – This one is broken
16. A – Here
17. B – Found it
18. C – okay perfect
19. A – Okay it has to be orange right
20. B – not orange and medium
21. A – yeah
22. B – Between B and small and not yellow [checks if they are finished]
23. B – Between C and D, medium and large and it could not be pink
24. [agreement noice, C and A are helping each other, B surveys]
25. B – and between D and A, large and it could not be orange
26. C – Oh, this one is fine,yea
27. B – That's it
28. [C closes valve 01.37]

Missed objects – 1

Transcription group 2

4-M

Trial 2-1

1. [Immediately begin looking around]
2. [ABCD have begun looking around. D and B are looking around the room, A and C have found the checklist at 00.08]
3. A – I have a role of paper here as well and I have found the instructions here
4. D – I have found some as well
5. [ABCD continue looking around the room and placing all of the pipes on the table]
6. A – Oh here is another one
7. B – Has someone read the instructions already?

8. A – Uh yes but-
9. D – Have you looked up there already?
10. D – The instructions are here, there is a lot, if this one is empty go to step 3...
11. [ABCD have all moved towards the instructions]
12. D – If oxygen is broken step 3, if valve is broken step 4
13. B – Yeah right, Now we need to see where the issue is
14. [ABCD move towards the puzzle]
15. D – Uhh,
16. C – So we are fixing the oxygen right
17. D – yeah
18. D – Those are the issues, all the possible issues that are this thing and we need to determine which one is the
19. B – Are the pipes broken?
20. D – I don't think so
21. A – I mean they seem intact [Talking over each other]
22. D – I mean is that something we can tap or
23. A, B – Yeah yeah
24. A – They do have letters on them, I don't know
25. D – Yeah I assume Ah like this is an L, this is an M [Multiple voices]
26. A – This one is also an M
27. D – Yeah
28. [All of them are still concentrated around the puzzle]
29. B – We have a lot of L's
30. D – And one S
31. B – I am going to check the [Talk over each other]
32. D – I think the pipes are okay
33. [B moves toward the checklist]
34. D – They look pretty and thanks
35. C – If I think I and M are right Medium, Large Small
36. D – Oh that's it
37. C – Medium Large [pikes up pipes]
38. [B is looking around for more pipes]
39. A – But how do we like determine, we have to determine the problem first
40. C – So yeah, the see if the oxygen tank is empty
41. [B moves toward checklist]
42. D – The pipes are broken or the valve is
43. {researcher intervention, how a broken pipe looks}
44. B – There are a lot of these broken actually
45. [All concentrate around the puzzle]
46. D – Okay well then, this one is broken
47. C – And this one [02.24]
48. B – The valve here is also broken
49. D – Okay then we need the pipe
50. [C and D move toward the checklist]
51. C – So the pipe is step 3, all of this then
52. [A also moves toward checklist]
53. D – The oxygen tank is empty, can we see if the oxygen is
54. [A and B move toward puzzle]

55. B – Uuuh
56. D – There is a hole in it so we can [All move toward puzzle]
57. Yeah [Talking over each other]
58. D – It could be where [A lot of mumbling]
59. {Researcher intervention- oxygen tank can open}
60. B – Open it
61. D – AAh
62. C - Oh yea
63. B – Oh it is broken [02.52]
64. C – Shit
65. [Laughing]
66. B – yeah it is broken
67. C – Shit alright
68. [C and D move back toward checklist]
69. A – all issues
70. C – So we need all the steps
71. D – So we need to do the oxygen tank, because that is step .., yeah
72. B – okay
73. C – If the valve is broken first fix the valve
74. [A also moves toward checklist]
75. D – Okay, I guess we fix the valve
76. C – If pipes are broken, do not open the valve until the pipes are fixed, that is step three
77. D – No no no, you are still in step 4, you just need to replace the valve and the next step is open the valve but we should still replace the valve, uuh
78. C – I don't know, I don't know how this works
79. D – yeah let's go with the pipes first
80. D – The pipes are broken close the valve
81. [B closes the valve]
82. A – So what's the first step?
83. C – Close the valve
84. D – So we first close the valve
85. B – Let's just as much as possible
86. B – yeah it is closed
87. B – Okay it's all good, so now we replace the pipes
88. [All moved back towards the puzzle]
89. B – So can you read the instructions, A?
90. [A and D moved towards the checklist]
91. A – Well if eeh, the valve is closed, I guess that would mean, replace the oxygen tank
92. B – That old thing, but how can we
93. [Mumbling]
94. A – Oh yeah, we can't open the valve until the pipes are fixed
95. B – Okay yeah, so if we have to fix the pipes how do we fix the pipes [mumbling]
96. A – uuuh
97. D – We need to close the valve
98. A – and then uuh, we have done that
99. [B and C stare at puzzle]
100. D – Replace the pipe with a matching of the correct size
101. B – Okay so and L pipe we have to..

102. D – But there is more to it
103. B and C – Okay
104. [B and C are fumbling, B appears to do nothing]
105. D – There is a connection piece, so there is between A and B, B and C , C and D, D and A, and then it lists the different sizes and then it lists the connection piece, so A B C D and then there are forbidden colors
106. A – Forbidden colors
107. B – Okay so let's focus on A B then
108. A – yeah
109. B – Cause we have a yellow pipe and a purple pipe that would fit AB
110. D – Okay pink is forbidden
111. B – Pink is forbidden?
112. D – Yeah
113. C – This is a large..
114. B - Let's use the yellow one
115. [C hands the yellow pipe to B]
116. C – the yellow one
117. B – yeah
118. A – Wait you are now connecting?
119. B – A and B
120. A – A and B
121. B – Pink was forbidden
122. A – Between A and B is large and forbidden colour is pink
123. B and C – yeah yeah
124. D – But there is also connection piece A, but I am not really sure what that means
125. B – That is probably for the valve
126. [Agreement noises]
127. B – And then B to C?
128. A – That's small, the pipe size
129. B – Okay and
130. A – then the forbidden color is green
131. B – It has to be green
132. D – No the forbidden is green
133. B – Oh sorry we have a tiny, it can be purple right?
134. D – uhh yeah
135. B – The pink one I mean
136. D – Yeah, small green
137. B – Okay and then we have D and C
138. D – yeah
139. D – Medium pipe and anything but yellow
140. A – yeah
141. [D surveys a bit, C hands pieces to B who puts them in place]
142. B – okay cool cool
143. C – is the other one broken?
144. B – no, this one is fine
145. C – okay
146. B – This one is fine, I think the pipes are fixed now
147. A – okay

148. B – Okay so what do we fix now
149. D – Now we open the valve
150. B – okay
151. {buzzer sound}
152. [Talking over each other]
153. C – We still have to do the oxygen
154. B – yes this pipe well
155. D – So we closed the valve
156. [ACD are at the checklist]
157. C – This one
158. D – No that one, I'm not sure
159. D – D and A
160. B – This one is not broken
161. D – oh okay
162. A – Well, but maybe, I guess we have to replace the oxygen? That's all I can think about
163. B – but how
164. B – Look we have oxygen here [opens oxygen tank] and there is a piece of oxygen broken, so we should find more oxygen somewhere
165. C – We can't do it because we're missing oxygen
166. B – I don't know maybe find something that looks like oxygen
167. D – Well we kind of scavenged the whole place
168. [Everyone begins to look around]
169. B – I know, I know
170. D – Have we looked behind all of the dudes
171. B – All of the dudes
172. A – This is just pictures
173. B – Does it say how to replace the oxygen?
174. AD – No just replace the oxygen
175. B – Oh I found it [07.40 all pipes found]
176. C – found it?
177. D – Oh damn that's hidden
178. B – okay the oxygen is fixed
179. C – Okay the oxygen is fixed
180. A – And now uuhm
181. [A and D move toward checklist]
182. B – There is a broken valve part maybe [mumbling]
183. A – yeah it is alright, now we could just open the valve
184. [07:59]

Missed objects- 0

Trial 2-2

1. ABCD – okay let's go
2. B – Okay there is all stuff again so let's just collect

3. [agreement noise and everyone begins searching]
4. A – Ah I see what the new problem is [00.13]
5. D – Yeah, it is the valve
6. A – Oh no maybe we have instructions? Oh I see it there on the floor [00.17]
7. C – Alright I will just scavenge around if you guys will just
8. [D near checklist, B near puzzle, A and C scavenging]
9. B – Okay let's go
10. D – So step one, determine cause, if oxygen tank is empty go to step 2,
11. B – The oxygen tank looks all good to me
12. D – All good, okay if pipes are broken step 3
13. B – There are pipes broken
14. D – yes okay now, if pipes are broken close the valve, if the valve is broken first fix the valve
15. B – The valve is broken
16. D – Indeed, there is the correct valve, so
17. B – Can I just replace it or do I need..
18. D – Yeah it just says if pipes are broken close valve warning if valve is broken first fix the valve, so I guess that's the yeah
19. [A stands at the side near checklist, D at checklist, C begins to assist B with puzzle]
20. B – Soo and then we close it right?
21. D – Yeah, yeah, close it
22. B – Okay
23. D – Replace the pipe with a matching pipe of correct size
24. B – So we have CD both pipes are broken
25. D – CD okay, the correct size is small medium
26. B – Uh yeah, we have one small one medium, so start with the small one
27. A – The forbidden color is yellow
28. C – yellow [hands orange pipe to B]
29. B – And then medium pipe is also broken
30. A – It's not, we can't have yellow
31. B – okay then, can we have yellow in AB
32. D – AB, yeah we can have yellow in AB
33. B – We will switch
34. [enlightened noises]
35. C – ooh your smart
36. D – I would not have figured that out
37. C – I was looking at it as well
38. B – AD is also broken [02.04]
39. D – AD uuh yeah, we need a large pipe and it cannot be pink
40. B – Alright
41. A – The oxygen levels are they uuh..
42. B – They are good yeah
43. B – Now we just open the pipe yeah
44. C – open the valve [02.25]

Missed objects - 1

Trial 2-3

1. B – Okay let's go
2. [All of them immediately begin to search for pieces]
3. B – Alright let's see what the problem is
4. [A picks up checklist 00.15]
5. C – Valve is okay
6. B – Oxygen, one of the tanks is broken [00.19]
7. C – And pipes obviously
8. B – Well how do we fix them
9. [B at puzzle, A at checklist, other searching] [valve still open]
10. B – We have the oxygen,
11. C – yeah
12. B – So what do we have to do first
13. A – I guess, I see one AD
14. B – Should we close the valve first? [B closes valve]
15. A – Oh yeah sure
16. B – Where do you wanna start? AD?
17. C – yeah
18. A – Yeah
19. [C joins B at puzzle, D joins A at checklist] [all pipes found 00.40]
20. A– AD uuuh, Medium no green
21. B – Medium?
22. C – That one is large?
23. B – AD?
24. A – Yeah says medium
25. B – Very well, put medium on it, and no?
26. A – No green
27. [C hands B the pieces]
28. B – Okay, BC then
29. A – Medium, no yellow
30. B – Okay then we have DC [broken pipes found 01.15]
31. A – Large small
32. B – and what
33. D – no orange
34. B – small large one? We have a small one already
35. D – Well if the small one is okay
36. A – A medium no orange
37. B – Okay, is that correct
38. D – No wait, we need a large one
39. B – A large one
40. D – yeah
41. C – That one is small, this one
42. B – okay yeah
43. C – and it is not orange so we're okay
44. B – yeah
45. A – open the valve
46. B – Okay and then what should we do next

47. B – do we have to close the valve
48. D – yeah
49. C – The valve is closed
50. B – we still need to [mumble] [replaces oxygen]
51. A – open the valve [01.58]

Missed objects - 0

Trial 2-4

1. [They all immediately begin searching for pieces]
2. [Checklist found at 00.10]
3. A – eeeh [A is at checklist, B moves toward puzzle]
4. B – If the valve is broken we should fix the valve first right?
5. A – Yeah alright, Valve is broken? [00.10]
6. B – Yeah the valve is
7. A – Alright, it needs to be closed so
8. B – Now it is closed
9. A – Okay now we are going to fix the pipes
10. [C and D now near table]
11. A – if it is one.. [interrupted]
12. B – Eeh oxygen is …
13. C – is this broken I just want to know?
14. B – yeah, okay so AB then
15. A – AB is medium no orange
16. [C still searching, D is handing pipes to B]
17. B – Okay, then we need BC
18. A – It is small no yellow
19. B – Then we have DC the small one [00.55]
20. A – Medium no green
21. [C now at checklist]
22. C – Medium or large
23. B – Okay Medium or large
24. [agreement noise]
25. A – Well you have already one large size so
26. B – Oh yeah then a medium not green
27. A – Yeah no green
28. C – Alright
29. B – Okay that seems alright
30. B – Lets open the valve again
31. A – Is the oxygen alright?
32. B – yeah
33. [D closes valve 01.19]

Missed objects – 2

Transcription group 3

2 – M, 1 –F

Trial 3-1

1. A - That's broken
2. B - That's broken, okay
3. [ABC looking around]
4. B – yeah
5. [A tries to open a pipe but is held back by researcher]
6. B – Oh there it is [Checklist found: 00.22]
7. [ABC all near checklist]
8. A – Okay so first we have to do what, determine the cause
9. C – Cause of the
10. [All of them move towards the puzzle]
11. A – Like the oxygen tank isn't working
12. C – yeah, and what is the oxygen, ah this one
13. A – This, this
14. B – yeah
15. A – Can we open it?
16. C – yeah
17. B – Okay so
18. A – Okay so this is broken, this is not broken, this is not broken, one thing is broken [01.24]
19. [mumbling, talking over each other]
20. A – So it is not empty, because these two are working, so it is just one is broken
21. [B and C move toward checklist]
22. C – Okay
23. A – So we got two possibilities
24. [A joins at checklist]
25. C – Oxygen and the valve, pipes are broken
26. [B and A go toward puzzle]
27. B – The valve looks
28. A – This is the valve
29. C – It looks good
30. A – It is open, it is the..
31. [Talking over each other, all go toward the checklist]
32. B – It is the pipes that are broken
33. A – Step 2 [mumbling] first we need to [mumbling] and replace the oxygen
34. B - [mumbling]
35. [All go toward the puzzle]
36. A – okay, so close the valve
37. [B closes valve]
38. B – Okay
39. A – And then replace the oxygen
40. [A went back to checklist, BC are beginning to search]

41. A – Wait wait, if there are broken pipes do not open... Okay so we have to keep the valve closed until we fix the pipes
42. BC – The pipes okay
43. [AB go searching, C looks at checklist]
44. A – We have to replace the oxygen, we have, maybe this is like [picks up oxygen] one with which we can replace it with
45. B – Yeah
46. A – The broken one
47. [ABC now near puzzle]
48. A – And now it should be working
49. B – yeah
50. A – So we can close it and open the valve
51. [C tries to open valve but buzzer sounds, A walked towards checklist]
52. B – Alright we keep that closed, the pipes are still broken
53. [BC go toward checklist]
54. C – Wait what?
55. B – The pipes are broken, so we have to, there is step 3
56. A – Ah
57. B – If the pipes are broken, close the valve, if the valve is broken first fix the valve
58. A – okay
59. [mumbling]
60. A – Okay so wait, which connection is broken
61. [AB go toward puzzle]
62. B – We have A to B is broken
63. A – A to B
64. [A moves back towards checklist]
65. B – C and B is broken and D and C [03.24]
66. A – Okay so A to B we need a large pipe size and the connection piece is A and we cannot use the pink one
67. [A stays near checklist, C begins to walk near puzzle, B is at puzzle]
68. B – Ah
69. C – So we have to use the yellow one then right?
70. [BC begin searching]
71. A – No it can be green or [mumbling]
72. A – Yeah, but yellow you can't use
73. B – Alright
74. [B only picks up yellow large]
75. B – Then
76. A – And it is large
77. B – yes
78. A – So you can use this one
79. B – Alright next
80. A – B to C right?
81. B – yeah, yeah
82. B – B to C is also broken
83. A – So we need a small pipe that connection piece B can
84. C – What colors?
85. A – not green, so either pink or yellow

86. [C begins searching for specific piece and gives it to B]
87. B – This one is broken, see the pink one there
88. C – Yeah there is a pink one
89. B – This one is not broken
90. [All are around puzzle]
91. B – Okay and then the last one
92. [A moves back toward checklist]
93. B – Alright is C to D
94. C – The second one
95. A – C is a connection piece not yellow one
96. B – Do we have an orange medium one right?
97. A – yeah it is, we need a medium one, yeah
98. B – yes, yeah alright
99. A – Okay then open the valve
100. [04.52]

Missing pieces – they only went searching for specific pieces and left the rest

Trial 3-2

1. A – First
2. [Checklist found 00.04, AB at checklist, C at puzzle]
3. C – We need to [mumbling]
4. A – Determine cause, oxygen tank empty, pipes are broken or valve is broken
5. C – This one is working
6. C – Valve is broken [00.22]
7. A – yeah it is broken
8. B – yeah
9. C – What else
10. [BC at puzzle]
11. A – and then the pipes are broken, okay soo need first close the
12. B – A and B
13. A – Okay but we cannot close the valve
14. B – no
15. A – Okay so we need first to fix the valve
16. B – yes
17. A – uuh replace the valve
18. C – Really?
19. A – yeah just replace the valve I don't know what we need to
20. [BC begin searching]
21. B – Oh there it is
22. A – Ah perfect, and then you replace this, but keep it closed, you cannot open it
23. C – oh, uuh ye
24. B – There we go
25. A – Perfect and then we can now like the pipes
26. [BC back at puzzle]

27. A – Okay so yeah
28. B – A to B is broken and B to C [01.23]
29. A – Okay between B and A we need a large one not pink
30. B - That's large yeah
31. C – Okay and between D and C?
32. A – uuuh, small or medium and not yellow
33. [C looks around]
34. C – maybe this one and this
35. C – Alright
36. [BC at puzzles placing pipes]
37. BC – Alright then
38. A – and then open the valve
39. [02.07]

Missing pipes: Still only searched for relevant pipes

Trial 3-3

1. [A finds checklist at 00.02]
2. A – Okay so again determine the cause
3. [BC near puzzle]
4. C – Okay we have a broken [00.08]
5. B – Oxygen tank
6. [mumbling, BC begin searching]
7. A – Perhaphs close the valve before
8. B – Oh, [closes valve], there we go
9. A – but yeah
10. C – we need a white one
11. [A stays near checklist, BC continue searching]
12. [A begins helping to search]
13. B – Carboard cutouts
14. B – Ah there it is
15. C – Got it
16. B – yeah it is over there
17. [A returns to checklist, C picks up piece]
18. A – Okay
19. C – Now we can replace it immediately right?
20. A – Yeah, because the valve is broken
21. B – Okay what else do we have broken
22. C – We have A to B broken,
23. A – A to B, ah medium one not green
24. C – We have medium one not green
25. B – I have not got it
26. C – I have one
27. [A briefly helps search]
28. A – Okay perfect [returns to checklist]

29. B – Now B to C is also broken
30. A – Medium not yellow
31. C – This one okay let's first [01.35]
32. B – Medium one not yellow
33. A – Not yellow
34. B – Got it, back there,
35. C – Where
36. B – Right there
37. C – Ah found it, that's large
38. B - That’s large
39. C – yeah
40. [A begins helping search again]
41. C – This one is
42. B – Oh
43. C – Green right?
44. B – Green works, okay
45. [All near puzzle]
46. B – and now D to C [01.57]
47. A - [Goes back to checklist] Large and not not orange
48. B – Large orange not
49. B – This one
50. A – if the if the yeah, if the small one is broken a small one if yeah
51. [02.25]

Missing pipes: Still only searched for relevant pipes

Trial 3-4

1. A – Okay so the valve is broken [00.02]
2. B – The valve
3. A – So we need to fix this first
4. B – The oxygen is
5. C – Good
6. A – So the valve and then the
7. [All begin searching for valve]
8. A – We need to find the
9. B – Here we go
10. A – Okay, then we can
11. [All gather around puzzle]
12. B – Close it
13. A – Yeah
14. B – Okay A to B is broken
15. [A finds checklist and stands by it 00.28]
16. C – C to B is also broken and C to D [00.31]
17. A – Okay A to B we need a medium one not orange
18. C – Yeah found one

19. B – Here is one as well [B is searching for pipes while C is replacing them]
20. A – Okay C to B is a small one and not yellow
21. [A helps search]
22. A – There is one
23. B – Alright okay
24. [A back to checklist]
25. A – and there is
26. C – C to D
27. A - [mumbling] a small one not green
28. C – So it is
29. A – A small one, not green
30. B – A small one
31. A – no that one is it is this
32. B – Medium
33. [BC search]
34. A – No medium medium medium, it is a medium sorry
35. C – So we need a medium one
36. A – A medium one that is not green
37. B – yeah
38. C - Sure
39. [ABC near puzzle]
40. B – And then the valve
41. [01.21]

Transcription group 4

5 – F

Trial 4-1

1. B – So
2. [laughing, all concentrated around puzzled]
3. B – So we have something, wait this is my stuff
4. A – What's the background, the background [laughing]
5. B – We're in a submarine, our oxygen tank is broke, Oh my god we need to fix it soon
6. A – Yeah okay, can we open it [refers to oxygen tank]
7. B – The middle one is fucking broke, okay [00.22]
8. [mumbling]
9. A - Let's turn it around
10. [laughing]
11. B – That is very smart yes
12. A – Look look
13. B – I don't think this is how it works
14. [D begins searching around the room and leaves the puzzle]
15. A – Okay, if Okay
16. D – [00.39] People

17. A – What
18. D – Manual
19. A – Wait why is the manual there [A moves towards manual]
20. [All move toward manual, B stays at puzzle]
21. [Researcher intervention as they try to move the manual]
22. D – If oxygen tank is empty go to step 2, okay what is wrong with it [B is still at the puzzle and checks oxygen]
23. B – The middle tube is broke
24. D – Okay, determine the cause, if oxygen tank is empty go to step 2, if pipes are broken go to step 3
25. B – Yeah they are all broken
26. D – Well, pipes are broken, close the valve
27. B – Valve is closed
28. D – If the valve is broken first fix the valve
29. [mumbling]
30. B – The valve seems fine
31. D – Okay
32. B – it is closed
33. [A moves back toward puzzle]
34. D – Okay, replace the pipe with a matching pipe of the correct size, eeh, what letters do we have
35. D – Between A and B we need a large pipe
36. B – Yeah a large green boy
37. D – Ooh there is pipes [Walks away from checklist] all over the place
38. E – Oh
39. D – OOh
40. [B, C, E begin searching]
41. D – So that's why we had to leave the room
42. B – We can't use this one for A and B, we have to use it for something else
43. D – We need a large green and a medium green
44. B – No, we just need a large one it doesn't matter what color it is, but we can't use the pink one
45. [A now at checklist, E is searching, B, C and D at puzzle]
46. B – As it is a forbidden color
47. C – Okay, is this okay
48. D – So the medium one goes here
49. B - Let's see
50. [A and B at checklist, C, D, E at puzzle]
51. B – A medium one has to go between C and D, forbidden color is yellow
52. D – No, it is orange it is fine
53. B – Okay
54. C – Have you [mumble]
55. E – Under the table
56. C – There is a piece I
57. E – Small
58. [laughing]
59. D – But also between C and B [02.39]
60. B – Between B and C we need a small one and green is not allowed

61. D – Then …
62. A - [mumbling]
63. B – No
64. D – Yeah okay and then we need, between A and B what was the forbidden color
65. B – Between A and B the forbidden color is pink and we need a large pipe
66. D – Then the yellow pipe
67. [B walks across the room]
68. B – There is another one over here [all pieces found 03.05]
69. D – What about inside, okay so we fixed the pipes
70. B – Yes
71. D – But what about inside the oxygen tank
72. [A and B walk back toward checklist]
73. B – Yeah
74. C – I also have this, I found this [hands oxygen tube to D]
75. D – She found the normal white, can we just replace it? Or do we need to..
76. C – Yeah I think
77. [A and B mumbling]
78. D – What does the manual say
79. B – Eeeh
80. D – Can we just
81. A – Is dit al gedaan? {Have we already done this?}
82. B – Yeah
83. D – Can we replace it inside the oxygen tank
84. B – Yeah, I think so, if that's the valve thing
85. D - It's white?
86. [A and B walk back toward puzzle]
87. C – I think it is the same size
88. D – I think it's fine
89. B – Yeah
90. D – All the broken pipes there and then we open the valve again?
91. [03.43]

Missing objects: 0

Trial 4-2

1. D – Okay so
2. E – Okay
3. B – Manual [00.02] [A, B walk toward manual]
4. D – Okay I can tell you something is different, the valve is broken [00.05]
5. [C Also begins to walk toward checklist]
6. B – Okay, close the valve
7. D – If the valve is broken, what to do
8. B – If the valve is broken first fix the valve
9. D – Oh, we have to find the thing don't we?
10. B – Yeah

11. [B, C, D, E begin searching, A at checklist,]
12. B – What do we need for the valve?
13. D – A valve, the …
14. B – A little
15. A – Replace the valve
16. D – yeah
17. [A also begins searching]
18. D – Yeah, the tubes on the table, that's a broken one, is it supposed to be broken?
19. [mumbling and talking over each other]
20. D – Just put the okay ones there and the broken ones there
21. B – Have we found the valve
22. A – What does the valve look like?
23. D – Eeeh like this
24. B – That is a small [Talking over each other]
25. D – I assume I can't just turn it around therefore
26. A – Oh it is here, okay
27. D – Yooo
28. A – Yoo, let's go, let's go
29. D – Oh no I pushed the pin in
30. [A back at checklist, B, C, D, E at puzzle] [pieces found, 00.55]
31. B – The valve
32. D – The valve is now closed
33. [B walks back to checklist]
34. A – Okay are the pipes also broken
35. B – Are the pipes broken?
36. D – Some are broken, the oxygen tank is fine
37. B – Okay
38. D – Some of them are broken oh boy
39. [talking over each other]
40. B – Which ones are broken?
41. D – A and D
42. B – A and D? Between A and D a large pipe, pink is not allowed
43. D – Large, yellow
44. E – D and C?
45. B – Between D and C, a small or medium pipe, yellow is not allowed
46. [C or E mumbling] - Small or medium pipe
47. D – A medium, eeeh, this one is fine, this one is fine, this one is fin- no this one is not fine [01.35]
48. E – Oh
49. B - Which one?
50. D – Eeh, C and D, so it needs to be medium or small
51. [Talking over each other]
52. B – Small or medium and not yellow
53. D – Not yellow
54. D – Two small ones I think
55. D – I am breaking all this, this one is fine, we fixed the valve
56. [Buzzer sound]
57. D - We're there

58. [buzzer sound]
59. D – Nope
60. [All back at puzzle]
61. A – Is the oxygen tank
62. B – Completed or is it empty?
63. D – it is [mumbling]
64. A – Is it?
65. D – Maybe I missed one
66. B – maybe there is a forbidden color
67. D – Wait maybe there is a forbidden color between those
68. B – Between A and B it can't be pink
69. D - That's fine, between C and B?
70. B – Between C and B it can't be green
71. D – Great and between C and B
72. B – Between C and B it can't be yellow
73. D – But small or medium right?
74. B – Small or medium, well it says small comma medium
75. E – Maybe one small, one medium?
76. [Talking over each other]
77. B – Yeah maybe one small, one medium
78. [Talking over each other, A is not understandable]
79. D – What color could it not be again? Yellow right
80. [multiple yesses]
81. B - Can't be yellow
82. [mumbling]
83. D – Then we do this one
84. B – And between D and A
85. [02.45]

Missing objects: 0

Trial 4-3

1. D – Oxygen tank
2. B – Do we need to close the valve?
3. D – Close the valve, the oxygen tank is broken [00.05]
4. B – Okay we need an oxygen
5. [Everyone begins searching, D stays at puzzle]
6. E – Oh it is there
7. B – It is there
8. D – I am going to move the broken pipes ahead of time [00.23]
9. B – Okay
10. D – We are so sufficient
11. B – Yes
12. [pipes found 00.28, checklist]
13. B – Okay between B and C

14. [A, B move toward checklist, C, D, E near puzzle]
15. C – Broke
16. D – Move it to the other pile [talking over each other]
17. B – Between C and B, medium that isn't yellow
18. [B walks slightly back to puzzle]
19. B – Between C and D we need eeh,
20. D – Medium?
21. B – Yeah and a large
22. D – Oh
23. [Talking over each other]
24. B – D and C, a large and a medium, eh, a large and a small, do we have a small one I think
25. E – Yeah
26. B – So we need a large that isn't orange
27. [A wanders back to puzzle]
28. C – yellow
29. D – I will take your [mumbling]
30. B - Let's see [Wanders back and forth between puzzle and manual]
31. B – Between D and A
32. D – A and D
33. B – We need a medium one that isn't green
34. D - [mumbling]
35. B – And it think that should be it [wandered back to puzzle]
36. [01.13]

Missing objects: 0

Trial 4-4

1. [all] - Valve is broken [00.04]
2. B – Okay let's find some
3. [A, B, E begin searching, D stays at puzzle while C checks oxygen, they talk over each other]
4. C – The oxygen
5. D – Thank is fine
6. [C also begins searching]
7. B – I found it
8. D – The valve
9. B – The valve
10. D – And some hair
11. B – yeah it is fine
12. B – And now we need to close it
13. D – The valve is closed
14. B – The oxygen
15. D – The oxygen tank is fine
16. B – Okay, now the broken pipes
17. [B walks toward checklist, 00.22]
18. D – Pipes, this one is fine, this one is also fine [00.29]

19. [Talking over each other, not understandable, all concentrate around puzzle except B]
20. D – That one is broke, also broke
21. D – Okay
22. B – Between A and B we need a medium pipe that isn't orange
23. D – Yup
24. B – Between B and C we need a small pipe that isn't yellow
25. D – Between C and D?
26. B – Between C and D we need a medium and a large that isn't green
27. B – And Between D and A we need a large that isn't orange
28. D - That's fine, now the valve is fine
29. [01.03]

Missing objects: 1

Appendix E

Evaluation Instrument for Each Group and Trial

Trial 1-1

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

147 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

598 seconds

        4. The time needed to find the checklist

5 seconds

        5. The time needed to find all the pipes

516 seconds with intervention

        6. The number of objects not found

0 objects not found, but intervention needed

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?

At first not (line 1 to 130), then they begin to comprehend. (with intervention)

    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

Only at line 130 could they predict and at 609 seconds they solved the puzzle

2. Feedback

N/A

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback
        3. Pendleton method

4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

609 seconds

2. The number of mistakes made

There were several mistakes made. (Line 7, line 11, line 14, line 17, line 20, line 22,) line 27, line 33, line 36, line 47, line 50, line 78, line 89, line 98, line 111, line 117, line 157

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

147 seconds

2. The time needed to find the broken valve

N/A

3. The time needed to find the broken oxygen tube

598 seconds

4. The time needed to find the checklist

5 seconds

5. The time needed to find all the pipes

516 seconds with intervention

6. The number of objects not found

0 objects not found but intervention needed

4. Closed loop communication
    1. The number of times closed loop communication was used

Lines 106-108

5. Effective teamwork
    1. The time needed to finish the puzzle

609 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?

They were talking over each other (line 80, 117, 140, 163). Line 129, 150 there was mumbling

5. Was there an effective handover of objects?
6. Was there a proper division of labor?

The team leader was switched in the middle (line 58), and near the end (line 128).

6. Use of checklists
    1. Was the checklist followed?

Yes, line 1 indicated that they followed a checklist.

    2. Was the checklist followed in its entirety?

Not really, indicated by line 5, 8, 18, 21, 27, 30, 36. The instructions were not read carefully, and the team members performed the wrong actions.

The second team leader also read the instructions wrong, line 78, and forgot about the oxygen tank.

The instructions were continuously read wrong in lines 89, 98, 106, 111, 117.

Needed intervention to read the checklist carefully (line 126).

They also needed advice to re-check the oxygen (line 158).

    3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

Yes, as indicated by line 5, 8, 18, 21, 27, 30, 36. The instructions were not read carefully, and the team members performed the wrong actions. The instructions for the pipes were read wrong as indicated by line 78. The instructions were continuously read wrong in lines 89, 98, 106, 111, 117.

They also needed intervention to read the checklist carefully (line 126).

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

Yes, line 17 suggested a solution (wrong solution). Also line 82, the suggestion of searching the room. Suggestion for better looking at 121 and 122. At line 128 the leader was switched again after a suggestion.

    2. Did the followers show initiative while solving the puzzle?

Yes, the team leader was switched (line 58, 128), and the now follower immediately relocated to a new position and took over the previous tasks. The followers automatically began looking for pipes at 83.

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)

Line 40 indicates that the leader becomes involved and tries to show the right example.

The second leader joins in when looking for pipes (line 83) and at line 92, 115 and 121. They also give an example at line 96.

        3. Did the leader make all of the decisions? (Autocratic leadership)

4. Did the leader make no decisions? (Laissez-faire leadership)
5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

The first leader mainly made decisions for what to do based upon what was indicated by the team members (line 16, 18, 21, 27). The second leader first established what everything was and proposed a new plan of action (line 62 to 74). The third leader gives clear instructions of what should happen (line 134, 146, 148, 152, 154), also upon suggestion from the followers.

6. Did the leader mainly support the team members? (Relationship-oriented leadership)

The first leader mostly supported the team members when they were doing the work with instructions (line 16, 18, 21, 27). The second leader gives suggestions for what is the correct pipes and corrects them gently (line 96). The third leader gives clear instructions of what should happen (line 134, 146, 148, 152, 154), also upon suggestion from the followers.

8. Briefing before doing a procedure
    1. Did the team have a briefing before they started the experiment?

No

2. Did the team members introduce themselves?

No

3. Did the team discuss a method or plan of engagement?

Yes, in line 1 it was indicated that they should check the checklist first.

4. Were there any questions or clarification asked?

No

5. Were there any concerns discussed?

No

6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?

No

7. Was a checklist used?

Yes, line 1

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?

8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 1-2

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

91 seconds

        2. The time needed to find the broken valve

22 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

2 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

2

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?

N/A

    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

N/A

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback

3. Pendleton method
4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

181 seconds

2. The number of mistakes made
3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

91 seconds

2. The time needed to find the broken valve

22 seconds

3. The time needed to find the broken oxygen tube

N/A

4. The time needed to find the checklist

2 seconds

5. The time needed to find all the pipes

N/A

6. The number of objects not found

2 objects

4. Closed loop communication
    1. The number of times closed loop communication was used

Lines 37-39

5. Effective teamwork
    1. The time needed to finish the puzzle

181 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

Yes there was arguing at 13

4. Did the team make mistakes while communicating with each other?

Yes there was talking over each other (line 8, 13) and there was mumbling (line 11, 28).

Moreover there was a misunderstanding at line 29 to 33.

5. Was there an effective handover of objects?

6. Was there a proper division of labor?

Yes, one person was at the checklist, one was searching, the other was at the puzzle

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Yes

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

Yes, briefly at line 11 to 13.

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

Yes, one of the followers stepped up when the leader did not understand the instructions (line 13). There was also a suggestion of what should be fixed first at line 11, 21, moreover there were questions asked (line 10).

2. Did the followers show initiative while solving the puzzle?

They showed initiative in line 13 when the instructions were wrong. The had also divided themselves properly, with one of them at the puzzle pointing out the mistakes and the other person searching the room.

3. What leadership style was used?
    1. Did the leader punish or reward his followers? (Transactional leadership)
    2. Did the leader make the team members follow them by example? (Transformational leadership)
    3. Did the leader make all of the decisions? (Autocratic leadership)
    4. Did the leader make no decisions? (Laissez-faire leadership)
    5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

The leader hands out the plan and the followers follow it, but they regularly check in with each other, with the followers making suggestions of what to do next (line 4, 7, 12, 13, 19, 21, 22, 26, 29 – 34, 35, 37).

6. Did the leader mainly support the team members? (Relationship-oriented leadership)

The leader mainly supported the followers by giving them instructions (line 4, 7, 12, 13, 19, 21, 22, 26, 29 – 34, 35, 37).

8. Briefing before doing a procedure

N/A

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?

3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 1-3

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

33 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

7 seconds

        4. The time needed to find the checklist

0 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

2

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?

N/A

3. When were the participants able to project the correct solution for the puzzle?
    1. When was the solution to the puzzle found?

87 seconds

2. Feedback

No

1. Did the team discuss what went well?
2. Did the team discuss what went wrong?
3. Did the team discuss what difficulties they faced?
4. Did the team discuss what could be improved?
5. Did the team discuss what steps could be taken to improve?
6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

87 seconds

2. The number of mistakes made

-

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

33 seconds

2. The time needed to find the broken valve

N/A

3. The time needed to find the broken oxygen tube

7 seconds

4. The time needed to find the checklist

0 seconds

5. The time needed to find all the pipes

N/A

6. The number of objects not found

2

4. Closed loop communication
    1. The number of times closed loop communication was used

Lines 12-14

5. Effective teamwork
    1. The time needed to finish the puzzle

87 seconds

    2. Did the team establish a clear goal?

No

    3. Were there any internal conflicts?

No

    4. Did the team make mistakes while communicating with each other?

Yes the leader rushed the explanation at line 25.

    5. Was there an effective handover of objects?

Yes they handed objects over, while giving indication (line 17-18, 21-24, 26-28).

    6. Was there a proper division of labor?

Yes, one of them was at the checklist, one was searching the room, and one was at the puzzle.

6. Use of checklists
    1. Was the checklist followed?

Yes

    2. Was the checklist followed in its entirety?

Yes, line 2, 10, 12, 15, 20, 23, 25, 27, 30

    3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

Yes, they remembered the puzzle and closed the valve earlier (line 9).

    2. Did the followers show initiative while solving the puzzle?

Yes, they closed the valve (line 9), they went searching automatically (line 5, 22).

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)
        3. Did the leader make all of the decisions? (Autocratic leadership)
        4. Did the leader make no decisions? (Laissez-faire leadership)
        5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

The leader simply outlined the steps, but also went along with the directions of the followers.

6. Did the leader mainly support the team members? (Relationship-oriented leadership)

The leader simply outlined the steps, but also went along with the directions of the followers.

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 1-4

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

38 seconds

2. The time needed to find the broken valve

14 seconds

3. The time needed to find the broken oxygen tube

N/A

4. The time needed to find the checklist

0 seconds

5. The time needed to find all the pipes

N/A

6. The number of objects not found

1

2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?

N/A

3. When were the participants able to project the correct solution for the puzzle?
    1. When was the solution to the puzzle found?

97 seconds

2. Feedback

No

1. Did the team discuss what went well?
2. Did the team discuss what went wrong?
3. Did the team discuss what difficulties they faced?
4. Did the team discuss what could be improved?
5. Did the team discuss what steps could be taken to improve?
6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

97 seconds

2. The number of mistakes made

No

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

38 seconds

2. The time needed to find the broken valve

14 seconds

3. The time needed to find the broken oxygen tube

N/A

4. The time needed to find the checklist

0 seconds

5. The time needed to find all the pipes

N/A

6. The number of objects not found

1

4. Closed loop communication
    1. The number of times closed loop communication was used

No

5. Effective teamwork
    1. The time needed to finish the puzzle

97 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?

No

5. Was there an effective handover of objects?
6. Was there a proper division of labor?

Yes one was at the checklist and the other two divided over the puzzle and looking around

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Unknown

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

No

2. Did the followers show initiative while solving the puzzle?

Yes, they automatically began looking around and even switched places, so that the other could look around. Moreover they began helping each other out. (2, 6, 9, 14, 24)

3. What leadership style was used?
    1. Did the leader punish or reward his followers? (Transactional leadership)
    2. Did the leader make the team members follow them by example? (Transformational leadership)

When there needs to be searching the leader began to help search. (line 14)

    3. Did the leader make all of the decisions? (Autocratic leadership)
    4. Did the leader make no decisions? (Laissez-faire leadership)
    5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

The leader was task oriented and read out the instruction, but took into account the time the followers needed to finish their tasks and regularly checked in on them. (line 6, 9, 12, 20, 22, 23, 25)

    6. Did the leader mainly support the team members? (Relationship-oriented leadership)

It was alright for the followers to show their confusion and the leader kept an eye on them. (line 19 - 25)

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 2-1

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

144 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

172 seconds

        4. The time needed to find the checklist

8 seconds

        5. The time needed to find all the pipes

460 seconds

        6. The number of objects not found

N/A

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?

At line 44 they begin to understand the puzzle

    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

479 seconds

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback
        3. Pendleton method
        4. Other/ informal feedback
3. Cognitive performance under stress
    1. The time needed to finish the puzzle

479 seconds

2. The number of mistakes made

(line 20, 35), 151

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

144 seconds

    2. The time needed to find the broken valve

N/A

    3. The time needed to find the broken oxygen tube

172 seconds

    4. The time needed to find the checklist

8 seconds

    5. The time needed to find all the pipes

460 seconds

    6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used

Line 106-108

5. Effective teamwork
    1. The time needed to finish the puzzle

497 seconds

    2. Did the team establish a clear goal?

No

    3. Were there any internal conflicts?
    4. Did the team make mistakes while communicating with each other?

Talking over each other (line 21, 31, 57, 152). Mumbling (58, 93, 95, 182), general misunderstanding 130- 132

    5. Was there an effective handover of objects?

The objects were handed over when requested (114-116, 141).

    6. Was there a proper division of labor?

Only around 85 one of them began to use leadership. Two of them were send to the checklist, but also two of them at the puzzle. One at the checklist sometimes does nothing.

6. Use of checklists
    1. Was the checklist followed?

Yes

    2. Was the checklist followed in its entirety?

Yes

    3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

Proposed a solution line 153, 170

    2. Did the followers show initiative while solving the puzzle?

One of them begins handing pipes to leader and they searched for pipes without instruction (line 168).

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader did help with searching for the pipes (168).

        3. Did the leader make all of the decisions? (Autocratic leadership)

The leader began to make decisions for what to do and the followers only followed them.

        4. Did the leader make no decisions? (Laissez-faire leadership)

At the beginning there was no leader and thus no decisions were made. There were also general decisions made.

        5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

The leader does listen to the instructions presented by the follower but directs them.

        6. Did the leader mainly support the team members? (Relationship-oriented leadership)
8. Briefing before doing a procedure

No

    1. Did the team have a briefing before they started the experiment?
    2. Did the team members introduce themselves?
    3. Did the team discuss a method or plan of engagement?
    4. Were there any questions or clarification asked?
    5. Were there any concerns discussed?

6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 2-2

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

124 seconds

        2. The time needed to find the broken valve

13 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

17 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

1

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

145 seconds

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback
        3. Pendleton method
        4. Other/ informal feedback
3. Cognitive performance under stress
    1. The time needed to finish the puzzle

145 seconds

    2. The number of mistakes made

Line 29

    3. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

124 seconds

        2. The time needed to find the broken valve

13 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

17 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

1

4. Closed loop communication
    1. The number of times closed loop communication was used

Line 20-22

5. Effective teamwork

1. The time needed to finish the puzzle

145 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?
5. Was there an effective handover of objects?
6. Was there a proper division of labor?

Yes one was at the checklist and the others divided themselves over the puzzle and searching the room

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Unknown

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

A suggestion at line 7, 33

2. Did the followers show initiative while solving the puzzle?

The initiated a search for the object and presented a team division.

3. What leadership style was used?
    1. Did the leader punish or reward his followers? (Transactional leadership)
    2. Did the leader make the team members follow them by example? (Transformational leadership)
    3. Did the leader make all of the decisions? (Autocratic leadership)
    4. Did the leader make no decisions? (Laissez-faire leadership)
    5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

The leader presented the tasks that had to be done and the followers mainly followed the plan, the followers all had their own tasks

6. Did the leader mainly support the team members? (Relationship-oriented leadership)

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 2-3

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

75 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

19 seconds

        4. The time needed to find the checklist

15 seconds

        5. The time needed to find all the pipes

40 seconds

        6. The number of objects not found

N/A

2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
3. When were the participants able to project the correct solution for the puzzle?
    1. When was the solution to the puzzle found?

118 seconds

2. Feedback

No

1. Did the team discuss what went well?
2. Did the team discuss what went wrong?
3. Did the team discuss what difficulties they faced?
4. Did the team discuss what could be improved?
5. Did the team discuss what steps could be taken to improve?
6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

118 seconds

2. The number of mistakes made

No

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

75 seconds

2. The time needed to find the broken valve

N/A

3. The time needed to find the broken oxygen tube

19 seconds

4. The time needed to find the checklist

15 seconds

5. The time needed to find all the pipes

40 seconds

6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used

Line 38-40

5. Effective teamwork
    1. The time needed to finish the puzzle

118 seconds

    2. Did the team establish a clear goal?

No

    3. Were there any internal conflicts?

No

    4. Did the team make mistakes while communicating with each other?
    5. Was there an effective handover of objects?
    6. Was there a proper division of labor?

Yes, lines 9 and 19. One was at the checklist and one at the puzzle, the other two were looking around and would then join one of the two.

6. Use of checklists
    1. Was the checklist followed?

Yes

    2. Was the checklist followed in its entirety?

No, line 14.

    3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

Yes, line 36.

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

They give indication of what is wrong (line 5, 7).

    2. Did the followers show initiative while solving the puzzle?

They voluntarily begin searching the room and go to new posts when a task is done.

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader is willing to listen to his followers and instructs them when they give indications. Is also willing to help in the puzzle process and fixes mistakes. Line 50.

        3. Did the leader make all of the decisions? (Autocratic leadership)

4. Did the leader make no decisions? (Laissez-faire leadership)
5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

They mostly follow the plan the leader gives them, while the leader checks in on them.

6. Did the leader mainly support the team members? (Relationship-oriented leadership)

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 2-4

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

55 seconds

2. The time needed to find the broken valve

10 seconds

3. The time needed to find the broken oxygen tube

N/A

4. The time needed to find the checklist

10 seconds

5. The time needed to find all the pipes

N/A

6. The number of objects not found

2 objects

2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
3. When were the participants able to project the correct solution for the puzzle?
    1. When was the solution to the puzzle found?

79 seconds

2. Feedback

No

1. Did the team discuss what went well?
2. Did the team discuss what went wrong?
3. Did the team discuss what difficulties they faced?
4. Did the team discuss what could be improved?
5. Did the team discuss what steps could be taken to improve?
6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

79 seconds

2. The number of mistakes made

No

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

55 seconds

2. The time needed to find the broken valve

10 seconds

3. The time needed to find the broken oxygen tube

N/A

4. The time needed to find the checklist

10 seconds

5. The time needed to find all the pipes

N/A

6. The number of objects not found

2 objects

4. Closed loop communication
    1. The number of times closed loop communication was used

Line 22-24

5. Effective teamwork
    1. The time needed to finish the puzzle

79 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?

Yes, interruption at line 11.

5. Was there an effective handover of objects?

Objects were handed over nicely, line 16.

6. Was there a proper division of labor?

One was at the checklist, one was at the puzzle, the other two were searching or later went to join one of them.

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Unkown

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

Yes, line 25.

2. Did the followers show initiative while solving the puzzle?

Yes, they went to search on their own volition and if they had no more task they went to join one of the others.

3. What leadership style was used?
    1. Did the leader punish or reward his followers? (Transactional leadership)
    2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader was at the puzzle, solving it while listening to instructions of one of the followers and took suggestions from the followers.

    3. Did the leader make all of the decisions? (Autocratic leadership)
    4. Did the leader make no decisions? (Laissez-faire leadership)
    5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
    6. Did the leader mainly support the team members? (Relationship-oriented leadership)

The leader addressed the concerns of the followers, line 31.

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 3-1

THE ESCAPEROOM THAT SAVES LIVES

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

204 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

84 seconds

        4. The time needed to find the checklist

22 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

N/A, they only went searching for specific pieces

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

292 seconds

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback
        3. Pendleton method
        4. Other/ informal feedback
3. Cognitive performance under stress
    1. The time needed to finish the puzzle

292 seconds

    2. The number of mistakes made

Line 51

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

204 seconds

    2. The time needed to find the broken valve

N/A

    3. The time needed to find the broken oxygen tube

84 seconds

    4. The time needed to find the checklist

22 seconds

    5. The time needed to find all the pipes

N/A

    6. The number of objects not found

N/A, only went searching for specific pieces.

4. Closed loop communication
    1. The number of times closed loop communication was used

No

5. Effective teamwork
    1. The time needed to finish the puzzle

292 seconds

    2. Did the team establish a clear goal?

No

    3. Were there any internal conflicts?

No

    4. Did the team make mistakes while communicating with each other?

They were talking over each other (line 19, 31), and mumbling (line 19, 33, 34, 59, 71). General confusion near 66-78

    5. Was there an effective handover of objects?

They went searching for pieces and gave them to each other.

    6. Was there a proper division of labor?

There was no general division of labor (Line 3, 10, 21, 24, 26, 31, 35, 40, 43, 47, 51, 53, 61, 67, 70, 86, 92).

6. Use of checklists

1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Yes

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

The pipes are still broken, line 51.

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?
    2. Did the followers show initiative while solving the puzzle?
    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)
        3. Did the leader make all of the decisions? (Autocratic leadership)
        4. Did the leader make no decisions? (Laissez-faire leadership)

There seems to be no general leadership and there is more of a general interaction, with no leader established.

        5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
        6. Did the leader mainly support the team members? (Relationship-oriented leadership)
8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?

8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 3-2

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

83

        2. The time needed to find the broken valve

22 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

4 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

N/A

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

127 seconds

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback
        3. Pendleton method
        4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

127 seconds

    2. The number of mistakes made

No

    3. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

83 seconds

        2. The time needed to find the broken valve

22 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

4 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used

No

5. Effective teamwork
    1. The time needed to finish the puzzle

127 seconds

    2. Did the team establish a clear goal?

No

    3. Were there any internal conflicts?

No

    4. Did the team make mistakes while communicating with each other?

They did mumble (line 3).

    5. Was there an effective handover of objects?
    6. Was there a proper division of labor?

Yes, one of them stayed in general near the checklist and the other two were either at the puzzle or searching. Line 2, 10, 20, 26, 33, 36

6. Use of checklists
    1. Was the checklist followed?

Yes

    2. Was the checklist followed in its entirety?

Unknown

    3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?
    2. Did the followers show initiative while solving the puzzle?

The followers went searching around the room without any indication.

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)
        3. Did the leader make all of the decisions? (Autocratic leadership)
        4. Did the leader make no decisions? (Laissez-faire leadership)
        5. Did the leader make a plan for the puzzle? (Task-oriented leadership)

The team mostly followed the leader with the plan from the checklist.

        6. Did the leader mainly support the team members? (Relationship-oriented leadership)
8. Briefing before doing a procedure

No

    1. Did the team have a briefing before they started the experiment?
    2. Did the team members introduce themselves?
    3. Did the team discuss a method or plan of engagement?
    4. Were there any questions or clarification asked?
    5. Were there any concerns discussed?
    6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
    7. Was a checklist used?
9. Effective and structured handover

N/A

    1. Was the SBAR method used?
    2. Were all the necessary materials handed over?

3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 3-3

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

95 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

8 seconds

        4. The time needed to find the checklist

2 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

N/A

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

145 seconds

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?

6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

145 seconds

    2. The number of mistakes made

No

    3. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

95 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

8 seconds

        4. The time needed to find the checklist

2 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used

Line 30 - 34

5. Effective teamwork
    1. The time needed to finish the puzzle

145 seconds

    2. Did the team establish a clear goal?

No

    3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?

Yes, they mumbled at line 6

5. Was there an effective handover of objects?
6. Was there a proper division of labor?

Yes, one of them stayed near the checklist and the others went near the puzzle or were searching.

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Unknown

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

Yes, they pointed out possible hiding places (line 13).

2. Did the followers show initiative while solving the puzzle?

They began searching and putting puzzle pieces together on their own volition.

3. What leadership style was used?
    1. Did the leader punish or reward his followers? (Transactional leadership)
    2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader directed the followers where necessary, but also helped in searching (line 12, 27, 40).

3. Did the leader make all of the decisions? (Autocratic leadership)
4. Did the leader make no decisions? (Laissez-faire leadership)
5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
6. Did the leader mainly support the team members? (Relationship-oriented leadership)

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?

7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 3-4

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

31 seconds

        2. The time needed to find the broken valve

2 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

28 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

N/A

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

81 seconds

2. Feedback

No

1. Did the team discuss what went well?
2. Did the team discuss what went wrong?
3. Did the team discuss what difficulties they faced?
4. Did the team discuss what could be improved?
5. Did the team discuss what steps could be taken to improve?
6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

81 seconds

    2. The number of mistakes made

Line 29

    3. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

31 seconds

        2. The time needed to find the broken valve

2 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

28 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used

No

5. Effective teamwork
    1. The time needed to finish the puzzle

81 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?

Yes, line 29, and mumbling at line 27

5. Was there an effective handover of objects?
6. Was there a proper division of labor?

Yes, one of them in general stayed near the checklist, while the other two spread out (line 7, 15, 19, 21, 24, 33, 39).

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

No, line 1-14 were done without checklist

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

Yes, line 27

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?
    2. Did the followers show initiative while solving the puzzle?

They voluntarily went to search around the room.

3. What leadership style was used?
    1. Did the leader punish or reward his followers? (Transactional leadership)
    2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader gives instructions but is willing to help search around the room.

3. Did the leader make all of the decisions? (Autocratic leadership)
4. Did the leader make no decisions? (Laissez-faire leadership)
5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
6. Did the leader mainly support the team members? (Relationship-oriented leadership)

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?

3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 4-1

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

159 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

22 seconds

        4. The time needed to find the checklist

39 seconds

        5. The time needed to find all the pipes

185 seconds

        6. The number of objects not found

N/A

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?

1. When was the solution to the puzzle found?

223 seconds

2. Feedback

No

1. Did the team discuss what went well?
2. Did the team discuss what went wrong?
3. Did the team discuss what difficulties they faced?
4. Did the team discuss what could be improved?
5. Did the team discuss what steps could be taken to improve?
6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

223 seconds

2. The number of mistakes made

Line 35

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

159 seconds

2. The time needed to find the broken valve

N/A

3. The time needed to find the broken oxygen tube

22 seconds

4. The time needed to find the checklist

39 seconds

5. The time needed to find all the pipes

185 seconds

6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used

No

5. Effective teamwork
    1. The time needed to finish the puzzle

223 seconds

    2. Did the team establish a clear goal?

Yes, line 5

    3. Were there any internal conflicts?

No

    4. Did the team make mistakes while communicating with each other?

Yes, there was mumbling (Line 8, 29, 54, 62, 77).

    5. Was there an effective handover of objects?
    6. Was there a proper division of labor?

One of them stayed near the checklist and one of them near the puzzle, the rest went around searching the room

6. Use of checklists
    1. Was the checklist followed?

Yes

    2. Was the checklist followed in its entirety?

Yes

    3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

Yes, line 35-37

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

They made suggestions on how to fix the oxygen, line 9. They also made suggestions for which pipe to use (line 52, 66).

    2. Did the followers show initiative while solving the puzzle?

They began searching on their own volition.

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader is leading by example and helping search for more pipes, they also took in suggestions from the followers.

        3. Did the leader make all of the decisions? (Autocratic leadership)
        4. Did the leader make no decisions? (Laissez-faire leadership)

5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
6. Did the leader mainly support the team members? (Relationship-oriented leadership)

8. Briefing before doing a procedure
    1. Did the team have a briefing before they started the experiment?

No

    2. Did the team members introduce themselves?

No

    3. Did the team discuss a method or plan of engagement?

Briefly, yes at line 5

    4. Were there any questions or clarification asked?

No

    5. Were there any concerns discussed?

No

    6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?

No

    7. Was a checklist used?

No

9. Effective and structured handover

N/A

    1. Was the SBAR method used?
    2. Were all the necessary materials handed over?
    3. Was all the necessary information given to the following team?
    4. Was a checklist used?
    5. Did the handover team discuss a plan?
    6. Was the handover accurate?
    7. Was the handover timely?
    8. Was the handover complete?
    9. Was the handover understandable?
    10. Was the handover unambiguous?

Trial 4-2

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?

1. The time needed to find the broken pipes

95 seconds

2. The time needed to find the broken valve

5 seconds

3. The time needed to find the broken oxygen tube

N/A

4. The time needed to find the checklist

2 seconds

5. The time needed to find all the pipes

55 seconds

6. The number of objects not found

N/A

2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
3. When were the participants able to project the correct solution for the puzzle?
    1. When was the solution to the puzzle found?

165 seconds

2. Feedback

No

1. Did the team discuss what went well?
2. Did the team discuss what went wrong?
3. Did the team discuss what difficulties they faced?
4. Did the team discuss what could be improved?
5. Did the team discuss what steps could be taken to improve?
6. What feedback model was used
    1. Feedback sandwich
    2. Chronological feedback
    3. Pendleton method
    4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

165 seconds

2. The number of mistakes made

The pin was pushed in too far, line 29. They solved the puzzle wrong at line 58.

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

95 seconds

2. The time needed to find the broken valve

5 seconds

3. The time needed to find the broken oxygen tube

N/A

4. The time needed to find the checklist

2 seconds

5. The time needed to find all the pipes

55 seconds

6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used
5. Effective teamwork
    1. The time needed to finish the puzzle

165 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?

Yes, they talked over each other, line 19, 24, 39, 51, 76, 78. And they were mumbling, line 19, 46, 63, 82.

5. Was there an effective handover of objects?
6. Was there a proper division of labor?

One of them stayed near the checklist in general while the rest searched around the room or where at the puzzle. (Line 3, 5, 11, 17, 30, 33, 60)

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Unknown

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

Yes, at line 44-46, they read the instructions wrong and placed a wrong pipe.

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

Yes, they asked questions where it was needed and devised a system for the broken and unbroken pipes (line 18, 20). When a mistake was made they carefully went over the process of what went wrong.

    2. Did the followers show initiative while solving the puzzle?

They devised a new system for the pipes and actively went searching for missing pieces.

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader gave instructions where necessary but also helped in searching the room where necessary and was ready for the followers. The also listened to the followers about what went wrong.

        3. Did the leader make all of the decisions? (Autocratic leadership)
        4. Did the leader make no decisions? (Laissez-faire leadership)
        5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
        6. Did the leader mainly support the team members? (Relationship-oriented leadership)
8. Briefing before doing a procedure

No

    1. Did the team have a briefing before they started the experiment?
    2. Did the team members introduce themselves?
    3. Did the team discuss a method or plan of engagement?
    4. Were there any questions or clarification asked?
    5. Were there any concerns discussed?
    6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
    7. Was a checklist used?
9. Effective and structured handover

N/A

    1. Was the SBAR method used?
    2. Were all the necessary materials handed over?
    3. Was all the necessary information given to the following team?
    4. Was a checklist used?
    5. Did the handover team discuss a plan?
    6. Was the handover accurate?
    7. Was the handover timely?
    8. Was the handover complete?
    9. Was the handover understandable?

10. Was the handover unambiguous?

Trial 4-3

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

23 seconds

        2. The time needed to find the broken valve

N/A

        3. The time needed to find the broken oxygen tube

5 seconds

        4. The time needed to find the checklist

28 seconds

        5. The time needed to find all the pipes

28 seconds

        6. The number of objects not found

N/A

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

73 seconds

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback
        3. Pendleton method
        4. Other/ informal feedback
3. Cognitive performance under stress
    1. The time needed to finish the puzzle

73 seconds

2. The number of mistakes made

No

3. When were all the elements, statuses and attributes perceived in the puzzle environment?
    1. The time needed to find the broken pipes

23 seconds

2. The time needed to find the broken valve

N/A

3. The time needed to find the broken oxygen tube

5 seconds

4. The time needed to find the checklist

28 seconds

5. The time needed to find all the pipes

28 seconds

6. The number of objects not found

N/A

4. Closed loop communication
    1. The number of times closed loop communication was used
5. Effective teamwork
    1. The time needed to finish the puzzle

73 seconds

2. Did the team establish a clear goal?

No

3. Were there any internal conflicts?

No

4. Did the team make mistakes while communicating with each other?

Yes, they were talking over each other (line 16, 23), and mumbling (line 29, 34).

5. Was there an effective handover of objects?
6. Was there a proper division of labor?

Yes, one of them stayed near the puzzle and one of them at the checklist the others wandered around.

6. Use of checklists
    1. Was the checklist followed?

Yes

2. Was the checklist followed in its entirety?

Unknown

3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?
    2. Did the followers show initiative while solving the puzzle?

They went searching on their own volition.

3. What leadership style was used?
    1. Did the leader punish or reward his followers? (Transactional leadership)
    2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader gave instructions where necessary and helped the followers along when they were searching.

3. Did the leader make all of the decisions? (Autocratic leadership)
4. Did the leader make no decisions? (Laissez-faire leadership)
5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
6. Did the leader mainly support the team members? (Relationship-oriented leadership)

8. Briefing before doing a procedure

No

1. Did the team have a briefing before they started the experiment?
2. Did the team members introduce themselves?
3. Did the team discuss a method or plan of engagement?
4. Were there any questions or clarification asked?
5. Were there any concerns discussed?
6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
7. Was a checklist used?

9. Effective and structured handover

N/A

1. Was the SBAR method used?
2. Were all the necessary materials handed over?
3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?

8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?

Trial 4-4

1. Situational awareness
    1. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

29 seconds

        2. The time needed to find the broken valve

4 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

22 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

1 object

    2. When was the relation of all the elements, statuses and attributes in the puzzle comprehended?
    3. When were the participants able to project the correct solution for the puzzle?
        1. When was the solution to the puzzle found?

63 seconds

2. Feedback

No

    1. Did the team discuss what went well?
    2. Did the team discuss what went wrong?
    3. Did the team discuss what difficulties they faced?
    4. Did the team discuss what could be improved?
    5. Did the team discuss what steps could be taken to improve?
    6. What feedback model was used
        1. Feedback sandwich
        2. Chronological feedback
        3. Pendleton method
        4. Other/ informal feedback

3. Cognitive performance under stress
    1. The time needed to finish the puzzle

63 seconds

    2. The number of mistakes made

No

    3. When were all the elements, statuses and attributes perceived in the puzzle environment?
        1. The time needed to find the broken pipes

29 seconds

        2. The time needed to find the broken valve

4 seconds

        3. The time needed to find the broken oxygen tube

N/A

        4. The time needed to find the checklist

22 seconds

        5. The time needed to find all the pipes

N/A

        6. The number of objects not found

1 object

4. Closed loop communication
    1. The number of times closed loop communication was used
5. Effective teamwork
    1. The time needed to finish the puzzle

63 seconds

    2. Did the team establish a clear goal?

No

    3. Were there any internal conflicts?

No

    4. Did the team make mistakes while communicating with each other?

They talked over each other at line 3 and 19.

    5. Was there an effective handover of objects?
    6. Was there a proper division of labor?

One of them stayed near the checklist, while one of them stayed near the puzzle.

6. Use of checklists
    1. Was the checklist followed?

Yes

    2. Was the checklist followed in its entirety?

No, lines 7-13 indicate that they did the checklist form memory.

    3. Did the team make mistakes with the checklist (reading a line wrong or giving the wrong instruction)

No

7. Leadership and followership
    1. Did the followers use critical thinking?
        1. Did the followers propose solution or alternative solutions?

They gave the correct puzzle pieces when needed.

    2. Did the followers show initiative while solving the puzzle?

They went searching on their own initiative.

    3. What leadership style was used?
        1. Did the leader punish or reward his followers? (Transactional leadership)
        2. Did the leader make the team members follow them by example? (Transformational leadership)

The leader read out instructions, but also helped searching and knew enough to follow suggestions from the followers.

        3. Did the leader make all of the decisions? (Autocratic leadership)
        4. Did the leader make no decisions? (Laissez-faire leadership)
        5. Did the leader make a plan for the puzzle? (Task-oriented leadership)
        6. Did the leader mainly support the team members? (Relationship-oriented leadership)
8. Briefing before doing a procedure

No

    1. Did the team have a briefing before they started the experiment?
    2. Did the team members introduce themselves?
    3. Did the team discuss a method or plan of engagement?
    4. Were there any questions or clarification asked?
    5. Were there any concerns discussed?
    6. Was the SBAR (Situation, Background, Assessment, and Recommendation) method used?
    7. Was a checklist used?
9. Effective and structured handover

N/A

    1. Was the SBAR method used?
    2. Were all the necessary materials handed over?

3. Was all the necessary information given to the following team?
4. Was a checklist used?
5. Did the handover team discuss a plan?
6. Was the handover accurate?
7. Was the handover timely?
8. Was the handover complete?
9. Was the handover understandable?
10. Was the handover unambiguous?