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Teams coping with unknown failures in aerospace and operational environments

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Introduction

Complex systems may imply to cope with unknown problems (neither expected nor experienced) despite the best conception they have. These problems will be all the more hazardous with operational, constrained and extreme environments. Expert operators of such systems may experience unknown failures in aerospace environments, like the Apollo 13's on board explosion and the crash of the Airbus A400M in Seville in 2015. This PhD's goal is to improve the performance of operational crews coping with unknown failures in aerospace environments. *In fine,* is a team sharing training composed of diverse and quality experiences more performant while coping with unknown failures than a team without such a shared and common training?

Chapter 1: hypotheses to test

The French air force academy training allows cadets to live diverse and quality experiences via activities scheduled during the first two years: military exercises, engineer courses, air force's traditions, boarding school, etc. A quality experience means that one of the experience's aspects is present in the concerned profession. Diverse experiences are different one another and do not belong to the professional technics' experiences. This PhD studies the influence of these diverse and quality experiences on the operational performance of teams during unknown problems' resolutions. Moreover, which experiences optimise the most a team's operational performance?

A group living and sharing diverse and quality experiences may enable one teammate to develop knowledge and skills about himself and the others. Indeed, when a cadet faces difficulties, he understands his own and colleagues' limits and how to manage them which could be metacognitive knowledge and/or skills. According to the Flavell's[1] definition, the meta cognition is relevant in this context taking into account the metacognitive knowledge and skills. No research (in the studied literature) deals with the impact of diverse and quality experiences on the metacognitive knowledge and skills of teams facing unknown problems. Thus, the metacognitive knowledge and skills presence is studied and especially their utility for the operational performance.

In parallel, the literature suggests some metacognitive models during problems' resolution. Be they individual or collective, these models are divided in different phases representing the evolution of the metacognitive processes. The interests of the team cognition[2] imply various inputs, reconsiderations, confirmations, new ideas, etc., *in fine* the cognition of several teammates toward a common goal. Some authors agree that these metacognitive models are not fixed during the cognition process (for example: Goos M et al.[3]) and teammates may switch from one phase to another, thus, the existence of a metacognitive phases' mixture. The metacognitive mixture's level (low or high) linked with a high performance is not detailed in the studied literature; schematic models representing this phenomenon (for example: Yimer A et al.[4]) are described. A good operational performance during a problem's resolution could result from a linear metacognition in order to perform a clear metacognitive progress but keeping a capacity to reconsider previous metacognitive phases. Then, a low mixture level linked with a maximum operational performance is expected during problems' resolutions.

Chapter 2: implying a mixed approach for a long-term protocol

The data is collected thanks to three teams of five persons each. Two are composed by cadets of the French air force academy. One team performs all the air force academy's training together; the team mates of the other one follows the same training but separately one another. The last team is built with service women and men without any relationship. They even did not know one another before the beginning of the PhD.

A mixed approach is needed to count the performance's level of teams and, in parallel, precise the metacognition in force during unknown problems' resolutions. Thus:

a. A quantitative approach necessary to measure the operational performance,

b. A qualitative approach permitting to study the metacognition way of use.

The qualitative approach is enriched by two methodological innovations. A metacognitive and collective model during problems' resolutions, established via a literature revue, is composed with phases. These phases make up the first division level of the model, *in fine*, the macro metacognitive approach. These metacognitive phases are then divided into a second and more detailed level of phases which is the micro metacognitive approach. Each teammate's intervention

is inserted in one of the first approach's phases, thus, a PhD with a macro metacognitive point of view. Afterwards, this approach permits a second innovation: the metacognitive clearness, used to measure the metacognitive phases' mixture.

To analyse the operational performance, metacognitive knowledge and skills and the clearness implies also to have these teams coping with unknown problems during the two-year training. Thus, the LETUCA protocol is created: Longitudinal Evaluation of Teams via Unknown and Collective Activities. Unknown problems' resolutions, *in fine*, the experiences, happen every forty-five days in laboratory conditions; thirteen are scheduled for twenty months. All these problems are specific, varied and most of them with space flight particularities.

A performance measure is also needed to evaluate teams according to their operational performance. Moreover, due to the variety of the LETUCA protocol's problems, one performance measurement per problem is designed, based on time, quantity or relevance.

Chapter 3: thus, multiple interests

The first interest of this PhD deals with team cognition while coping with unknown situations: the creation of the clearness, a metacognitive model and the macro and micro metacognitive approaches. Moreover, the advances may be widened to a broad spectrum of disciplines such as economy, governments' decisions, institutions' communication, defence and private operational activities, etc. Decision makings' improvements in terms of quality and quantity are expected.

The second interest consists of creating a full protocol focused on operational activities and testing performance of groups during long duration trainings or just for a one-shot test for large scale selections, for example: operational teams' selections. This protocol LETUCA respects these characteristics and requires just simple office equipment.

The third interest consists in improving crews' training in operational environments; especially with steps forward about the diverse and quality experiences' sharing and the influence it has on operational performance. Then, the comparison of the performance and the use of metacognition throughout the LETUCA protocol could be profitable by designing an optimal experiences' sharing and an optimised method for unknown failures.

Conclusion

Thanks to this PhD, steps forward are expected in unknown problems treatment and general team cognition. The study of operational performance in parallel to metacognition delivered by specific teams during the twenty month LETUCA protocol are the keys to reach such advances.

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Conflict of interest

Author declares that there is no conflict of interest.

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