How lack of situation awareness is involved in learning difficulties of ab-initio helicopter pilots?

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ABSTRACT

Flight instruction for *ab initio* helicopter pilots is crucial for the development of basic flight skills to ensure the safety during flight. Instruction relies on accurately assessing the learning progress of student pilots, enabling appropriate guidance for skill acquisition. However, for some students, instructors find it challenging to determine the origin of their learning difficulties. Situation Awareness (SA) is a core determinant in decision-making quality and is defined by Endsley as "perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future". Therefore, assessing SA in student pilots could provide insight into the nature of their cognitive and perceptual processes, and thus, facilitating the understanding of learning difficulties. Our study aimed to determine whether lack of SA is involved in the learning difficulties of helicopter military student pilots and how. The method consisted of a content analysis of evaluation forms completed by flight instructors after 6 flights in the navigation module for 20 military helicopter student pilots. Each comment written by flight instructors were classified according to five variables. Data analysis is currently in progress and aims at comparing learning successes and difficulties between student pilots who validated the navigation module and those who did not validate the module. Results will be presented at the conference.

KEYWORDS

Situation Awareness, Flight instruction, Navigation, Helicopter pilot

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1 INTRODUCTION

Flight instruction for *ab initio* helicopter pilots is crucial for the development of basic flight skills to ensure their safety during flight. In military context, success in instruction modules represents a high stake and many efforts are made to support student pilots to validate their piloting cursus and be able to quickly join operational squadrons. Identifying means to facilitate and improve flight instruction is therefore a crucial point. However, learning to pilot a helicopter is extremely demanding and difficult [1, 2]. Learning technical tasks is embedded in multitasking context, especially during navigation instruction where student pilots take the role of Pilot Monitoring (PM). This type of situation is demanding in terms of Situation Awareness (SA) and may generate high workload for student pilots.

Successful instruction relies on accurately assessing the learning progress of student pilots in order to enable appropriate guidance for skill acquisition, as it is described in the scaffolding model of instruction [3]. Yet, understanding the origin of learning difficulties remains challenging and may lead to misdiagnoses [4]. The goal of the study was to identify the difficulties encountered by military student pilots during navigation instruction and determine the extent to which a lack of SA contributes to the learning difficulties encountered. Comparisons will be made between students who succeeded to validate the navigation module and those who did not on the nature and the evolution of difficulties and successes during the module.

1.1 Flight navigation and situation awareness

Helicopter navigation for two-member crews is carried out in three main stages: navigation preparation, pre-flight briefing and in-flight navigation realization. Navigation preparation involves planning a timed route to a mission-specified target. This route is composed of several points associated with visual landmarks in the environment, and is chosen to avoid danger areas or not permitted airspace. The chosen route is then plotted on a flight map in order to follow this track in flight as accurately as possible. Pre-flight briefing aims to present the track to the crew and to discuss the choices and associated risks. During the flight, the PM is responsible for monitoring the track using the plotted flight map, the helicopter stopwatch, and by recognizing visual landmarks in the out-of-window environment. He then guides the Pilot Flying (PF) by providing orientation and speed instructions. The PM is also responsible for other tasks including radio communication and fuel management. This multitasking activity elicits a high demand for the elaboration, maintenance and sharing of SA.

According to the model of Endsley [5], SA is defined as ”the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status into the near future”. This definition refers to a three-level model of situation awareness where each level has an influence on the upper-level [5, 6]:

- Level 1: Perception of elements in the current situation
- Level 2: Comprehension of the current situation based on the perceived elements
- Level 3: Projection of the future state of the situation based on the comprehension of the current situation

In this model, the quality of SA is one of the key determinants of decision making. It is reflected by the significant proportion of aeronautical accidents related to a lack of SA [7]. The development of SA is considered as one of the eight core pilot competencies along with application of procedures, communication, aircraft flight path management (in automation and manual control), leadership and teamwork, problem solving and decision making, and workload management [8].

In flight navigation, level 1 SA includes detection of the visual landmarks that were identified during the navigation preparation, level 2 SA involves recognizing helicopter position within the plotted route and level 3 SA involves being able to anticipate the evolution of the trajectory both in terms of the route and the timing. The quality of SA is essential to be able to follow the planned track but also to develop effective strategies to recover from deviations either related to the route than the timing.

1.2 Sources of loss of SA among novice pilots

Loss of SA may be generated by failures at all the three levels of Endsley's model [5, 7]. In the first level, loss of SA may be generated by the fact that useful data has not been perceived. This level involves attentional processes but also information-seeking strategies and relies on one's expectations regarding situation evolution. The lack of knowledge of novice pilots may create difficulty in determining relevant environmental cues, leading to important information being overlooked or to a focus on irrelevant information relative to the encountered situation [9, 10]. Novice pilots are also less quick to direct attention to select flight-relevant information [11, 12]. Whereas expert pilots demonstrate comprehensive and efficient scanning patterns, especially in emergency situations [13], novices tend to fixate on fewer instruments for longer periods, leading to missed critical information and impaired situation awareness [14–16]. High cognitive load may also lead novice pilots to struggle with the high demands of processing and integrating information from various sources, such as instruments, navigation aids, and communications, particularly in complex environments or unexpected situations [17–19]. The cognitive load is even higher for student pilots who need to handle many tasks that are not fully automated yet, thus requiring significant attentional resources and cognitive resources for learning process [20].

Loss of SA in level 2 is related to the recognition of a known situation and loss of SA in level 3 is related to the ability to project the evolution of the situation including risk assessment. The lack of experience of novice pilots makes it difficult to recognize a flight situation, due to impoverished mental models and a weak understanding of the relationships between different environmental cues, leading to comprehension errors of the situation [9, 11, 13, 21–23].

In [24], Endsley emphasizes that pilots' SA improves with experience, as they gain better ability to recognize relevant cues, integrate information, and anticipate future events. We believe that lack of SA could be involved in learning difficulties and thus consolidating this competency starting at the ab-initio stage of instruction could be useful for flight instruction.

1.3 Objective and hypotheses

Our study aimed to determine the extent to which lack of SA contributes to the learning difficulties encountered by military helicopter student pilots during navigation instruction. Our main hypothesis was that difficulties related to SA would be proportionally more frequent in student pilots experiencing learning difficulties, such as those who failed to validate the instruction module, than those who did validate the instruction module. As student pilots have similar flight experience, we expected that the difference in lack of SA would be particularly observed in level one of SA.

2 METHODS

This retrospective study was based on the analysis of evaluations forms completed by flight instructors throughout the flight navigation instruction module. A content analysis was conducted on the evaluation forms of twenty military helicopter student pilots after six flights in low and very low altitude, both in simulation settings and real flights. The forms were compared as a function of student pilot's success or failure in the validation of the module.

The evaluation forms are composed of several sections related to the different pedagogical exercises that were performed by the student pilots during the flight instruction. Each of these exercises is commented on by the flight instructor after the flight debriefing. These comments may highlight successful learning points or may provide advice for improving specific flight skills. Sections may contain one or several comments. We considered a comment as associated to one specific learning object.

Comments were classified according to five variables in accordance with an expert flight instructor:

- **Learning domain** — Five learning domains were identified: Navigation Preparation, Navigation Realization, Flight Management (which refers to concurrent tasks other than navigation when student pilots are managing pilot), Piloting (which refers to periods of flight where student pilots are pilot in command) and Learning Process (which refers to the global learning progress of the student).
- **Learning object** — This category refers to a specific object within the learning domain. For example, in Navigation Preparation, a specific object is indications on flight map.
- **Piloting core competency** — This category includes the 8 piloting core competencies identified by ICAO (2013): Application of Procedure, Communication, Aircraft Flight Path

Management, Leadership and Teamwork, Problem Solving and Decision Making, Workload Management and Situation Awareness. The Situation Awareness competence was divided as a function of the three levels of SA.
- **Achievement of instruction objectives** — Two levels of achievement were distinguished: Success and Point of Improvement.
- **Overall flight instructor evaluation of the exercise** — The evaluation is performed on four levels: Good, Satisfactory, Low, and Insufficient.

For example, the following comment "*Take the time to position yourself by taking a closer look at the outside environment*" was coded as: NAVIGATION-REALIZATION/OUTSIDE_ENVIRONMENT_OBSERVATION/SITUATION-AWARENESS-L1/POINT_OF_IMPROVEMENT/SATISFACTORY.

The coding process is under progress. One researcher will code all the comments written by flight instructors after the six navigation flights of 20 student pilots. To ensure data reliability, a second researcher will code a quarter of the data and both codes will be compared. Finally, an expert flight instructor will verify one tenth of the data.

Statistical analysis will be performed by comparing student pilots who validated the navigation module in the first flight test and student pilots who needed more instruction flights to validate the navigation module. A comparison will also be performed to compare the evolution of their learning successes and difficulties.

3 PRELIMINARY RESULTS AND DISCUSSION

At the time of writing, data analysis of 120 evaluation forms (6 flights for 20 student pilots) is currently under progress. The results will be presented at the conference. Statistical analysis will be performed with chi-square tests.

The results will deepen our understanding of the difficulties encountered by student pilots during low and very low altitude navigation learning, while identifying the levels of situation awareness associated with these difficulties. Perspectives related to flight instruction applications will be discussed.

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