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ANALYSIS OF A POSSIBILITY TO CANCEL FLIGHT TIME BOUNDARIES IN PILOT TRAINING IN CONJUNCTION WITH COMPETENCE BASED TRAINING IMPLEMENTATION

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Introduction

Students around the world attend school every day in order to study various subjects. The courses aimed at teaching these subjects are based on a time schedule, encompassing certain amount of teaching hours during a school year. As these courses are time-based, the teacher has to follow some kind of schedule and check the progress. However, not every student is capable to follow the rate of the teacher. Some students may fall behind and never learn the whole lesson. On the other hand, there exist students which are faster than the prescribed rate of teaching and get bored or lose time sitting at school for longer than needed.

Similar situation exists in case of pilot training. A student learns to fly for a prescribed number of hours. The number of flight hours is prescribed by the licensing authority. But, does this amount of training guarantee that the student pilot is capable of correctly performing her/his job and all the related tasks?

This problem is solved by competence based pilot training. The new approach to training is directed toward achieving specific outcomes in opposite to achieving specific time. It is aimed at teaching an individual to perform a task to a specified standard under specified conditions. A standard feature of this type of training in other fields of industry is absence of minimal or maximal amount or volume of training. In this paper we will try to confirm a possibility to cancel these limits also in case of competence based pilot training.

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Data collection

In order to confirm the possibility to abolish minimum and maximum flight hour requirements in pilot training, we needed a data set showing flight time needed to gain proficiency in some task for a wider array of student pilots. We utilised data available at the Flight training organisation of the University of Žilina, which trains significant number of students per year.

The data consists of total flight time the student pilots needed to be skilful enough to execute their first solo flight. Duration of the proficiency check before the first solo flight is part of this time. These data was chosen because they are well defined and more important , well trackable and well captured in the particular students' documentation.

We collected 117 of these values, ranging from about 9 hours to about 20 hours of flight time.

Data processing

The number of 117 values n places our data sample to a large sample data category. At first we sorted the values into classes. Before the process of sorting, we calculated these values:

- Variation range

$$R = x_{\max} - x_{\min} = 20{,}25 - 8{,}42 = 11{,}83$$

- As n > 100, number of classes k

$$k = [10 \ln n] = [10 \ln 117] = 47$$

- Width of the class

$$h = \frac{R}{k} = \frac{11{,}83}{47} \cong 0{,}25$$

After class width determination we set upper and lower class boundaries. For the purpose of unambiguous value arrangement into the class when the value is exactly at two classes' common boundary, we added 0,01 to the bottom class boundaries.

Class means are representing intervals, into which the sample data will be grouped. These were rounded to 2 decimal places.

The next step was calculation of absolute frequencies, cumulative absolute frequencies, relative frequencies and cumulative relative frequencies.

Data characteristics

- Arithmetic mean

$$\bar{x} = \frac{1}{n}\sum_{j=1}^{k} x_j n_j = 13{,}02$$

Modus $\hat{x}$ is the most common value in the sample data. The biggest number of values belongs to class number 13, between boundaries 11,43 and 11,67. The centre of this class is 11,55, which is the modus we searched for. As the modus is somewhat lower than the arithmetic mean, there are more values below the arithmetic mean than above the arithmetic mean. However, the higher values differ from the arithmetic mean in greater extent.

Median $\tilde{x}$ is the middle value of the ascending arrangement of sample data values, because our n is odd. In our case it is the 59th value of the arranged sample data. $\tilde{x} = \mathrm{x}_{59} = 12{,}42$. This value is slightly lower than the arithmetic mean, which is caused by several high values in the range of 17 to 21, which differ greatly from both the value of arithmetic mean and the value of median.

All these characteristics can be seen on the following figure, showing histogram of number of values in different classes (absolute frequency) and centre of the class). Modus is depicted by the highest column of the histogram.

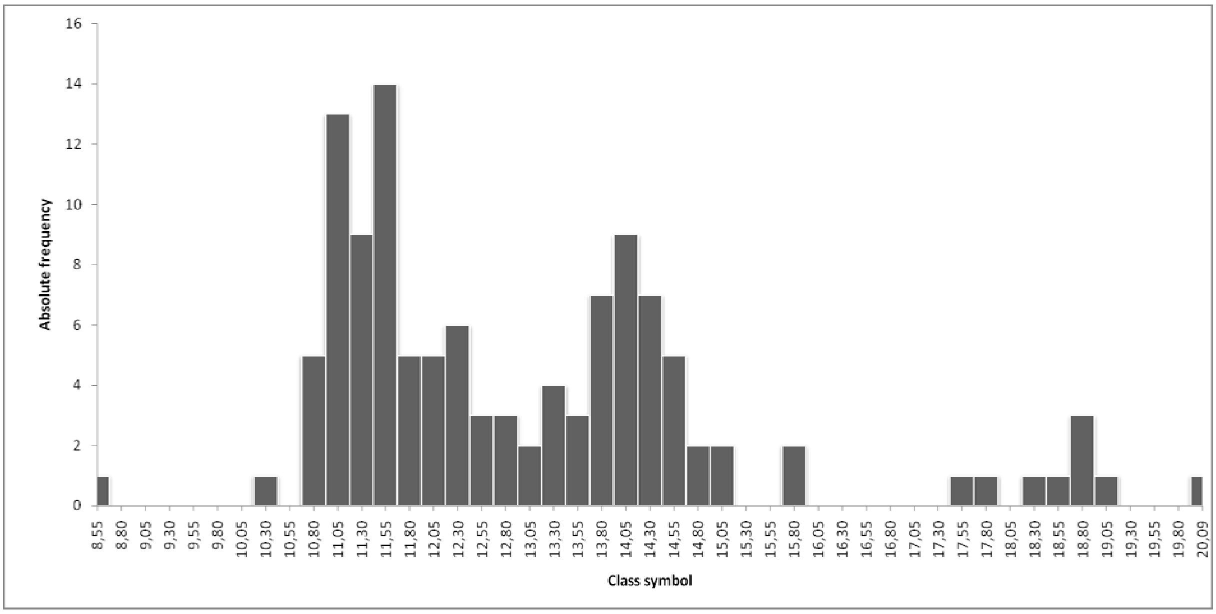

Figure: Histogram of the data arranged into classes

These three mean values, together with the figure above, confirm that it is not possible to determine a fixed flight time needed to reach competency. As we can see, the range from modus to arithmetic mean is approximately 1,5 flight hour. This represents a range of approximately 12% of median. This is a considerable difference. What is more, the main concentration of values ranges, according to histogram, is from about 11 to about 15 hours and represents approximately 32% of median value. This shows considerable differences in flight times needed to perform a solo flight. Because of these great differences between students, it is not possible to determine flight time needed for getting competent in a task.

Subsequently we determined several more variation and deviation characteristics. These characteristics deal mostly with confirmation of minimum flight hours cancellation possibility.

- Sample variance

$$s^2 = \frac{1}{n}\sum_{j=1}^{k}\left(x_j - \overline{x}\right)^2 n_j = 5$$

- Standard deviation

$$s = \pm\sqrt{s^2} = 2{,}13$$

- Coefficient of variation

$$V_x = \frac{s}{\overline{x}} \cdot 100[\%] = 16{,}36\%$$

The value of coefficient of variation means moderate variability. These three characteristics support the impossibility to determine a fixed flight time needed to reach competency, as stated above.

- Asymmetry

$$A_x = \frac{1}{n} \cdot \frac{\sum (x_j - \overline{x})^3 n_j}{s^3} = 1{,}25$$

As asymmetry is higher than 0, the peak of histogram should be to the left of arithmetic mean and more values will fall into the interval from 0 to arithmetic mean. This is actually caused by greater concentration of values in the interval between 10 and 12 flight hours, close to the arithmetic mean, but also a small concentration in the range from 17 to 21, which is quite far from the arithmetic mean.

- Excess

$$E_x = \frac{1}{n} \cdot \frac{\sum (x_j - \overline{x})^4 n_j}{s^4} - 3 = 6$$

As excess is much greater than 0, the histogram has a sharp peak. Both characteristics can be clearly seen on the histogram.

Although coefficient of variation is not too high, there are some values considerably different in comparison to the mean values. On the other hand, asymmetry clearly shows that the peak of values is left of the arithmetic mean and the excess shows that the peak is rather sharp. We can deduct, that although the values vary significantly, there are not many values far below the group of three main mean values (arithmetic mean, modus and median). It would be feasible to cancel minimum flight time requirements if the data sample had normal distribution and there would be enough values scattered far below the modus, which might have justified such decision. However, this is not the case and the data clearly shows it would be not justified. Because of this it is not feasible to cancel minimum flight hour requirement in pilot training.

We tried to support the preceding statement by normal distribution test on basis of asymmetry, which shall confirm if the random variable *flight time needed for first solo flight* has normal distribution.

In this test, we have to determine value of criteria K:

$$K = \frac{|A_x|}{\sqrt{\frac{6(n-2)}{(n+1)(n+3)}}} = 5{,}68$$

K is then compared with critical value of normal distribution u_α for selected α from the table below:

α	0,01	0,02	0,05	0,1	0,2
u_α	2,5758	2,3263	1,9599	1,6448	1,299

Table: Critical value of normal distribution [1]

As $K > u_\alpha$, for every α, the random variable *flight time needed for first solo flight* does not have normal distribution. This further supports the theory that it is not feasible to cancel minimum flight hour requirement in pilot training.

Conclusion

Although the statistical data analyses negates removal of the minimum flight time for training requirement, the fact, that it is not possible to determine a fixed flight time needed to reach competency, shows a possibility to create a hybrid system, where the sum of minimums for every task or phase of training may be lower than minimum for the entire course. This may lead to greater variability, providing for adjustments according to particular trainees capabilities in individual tasks. It would provide the flight instructor some buffer for unanticipated difficulties with a particular task or for time building in a task the student is interested in, in case the student is proficient in earlier stage of training. Apart from this, competence based training approach enables to use more training types than just class hours. Even if class hours are used, they should be of less theoretical and more practical nature. One part of this method provides opportunity to incorporate new technology into training. Good examples of such useful technology are iCPT (interactive cockpit procedure trainer), FMS (Flight management system) trainer, models of systems etc. On this occasion we have to mention a possibility to import technology from other fields like gaming industry creating high fidelity simulations. There is also a possibility to combine competence based training with scenario based training for greater quality of training and possibilities for easier and deeper learning. All these advantages should lead to greater integration of competence based training principle into pilot training. The proposed hybrid minimum flight time system may increase the efficiency of pilot training in terms of both, quality and economics.

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