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EGR 7050 Design and Analysis of Engineering experiments

Homework 1

1. *You want to improve the time (measured in minutes) of swimming the 100m freestyle (see this link to learn more about freestyle swimming:*

   http://www.usaswimming.org/DesktopDefault.aspx?TabId=2175&Alias=Rainbow&Lang=en

   Look at the section titled "Long Axis Strokes: Freestyle and Backstroke"). You can consider this to improve your time, or to improve the time of someone you are coaching. Begin the process of designing an experiment to study the time of swimming the 100m freestyle by completing steps 1- 3 of the guidelines for designing an experiment in Section 1.4 of the Montgomery text (pages 14- 18). Be sure to describe at least two factors in each of these categories: design factors, held constant factors and allowed to vary factors. Draw a cause-and-effect diagram to summarize your current understanding of the time of swimming the 100m freestyle.

   Solution:

   Recognition of and statement of the problem: There are many contributing factors to improve the time of swimming in the 100m freestyle. They are as follows: number of breaths they take to finish the 100m, stroke action, increasing the tempo of your movement, stroke rate, body position, strength of the kick.

   Selection of the response variable: The swimming time can be measured by the stroke rate and the length of the pool. The other response variables include: maintaining swim tempo and pauses and hitches in your stroke.

   Choice of factors, levels and ranges:

   Design Factors:

   The factors selected for study in the experiment are:

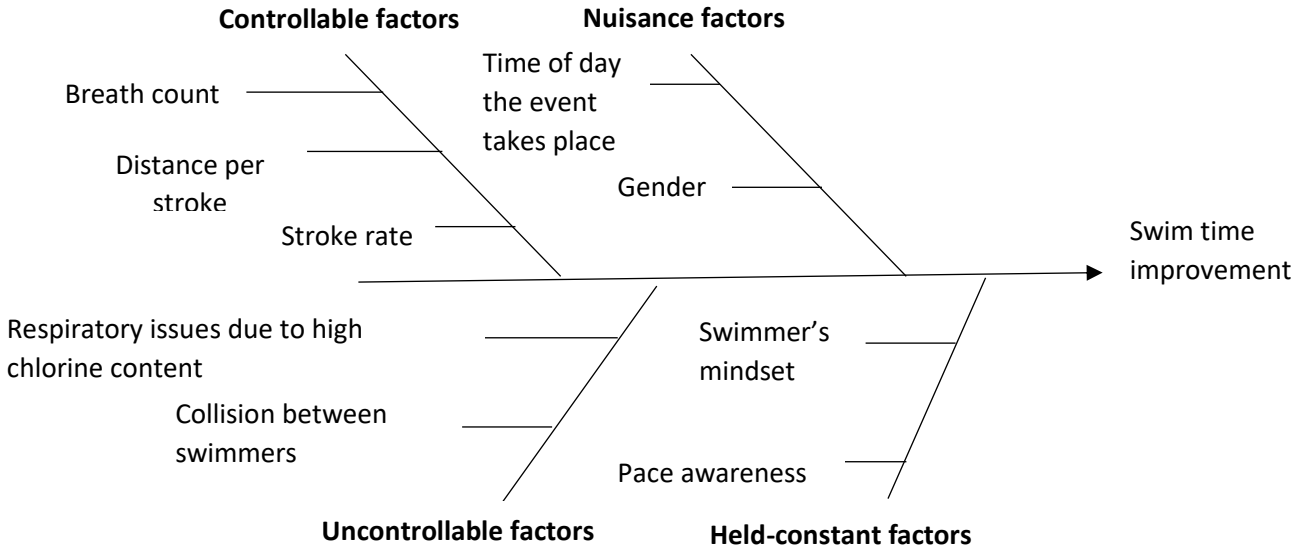
   - The number of breaths they take during swimming
   - The race strategy the swimmers follow: fast in the initial 50 and controlled in the last 50 or vice versa

   Held-constant factors:

   - Swimmer's mindset- It's expected to be fresh and motivated throughout the race
   - Pace awareness: Being aware of your pace throughout the race, can help you stick to the race strategy.
   - Maintain proper body balance in water

Allowed-to-vary factors:

- Number of swimmers in a pool
- Body type of swimmers – This varies between persons.



2. *Computer output for a random sample of data is shown below. Some of the quantities are missing. Compute the values of the missing quantities.*

Variable	*N*	*Mean*	*SE Mean*	*Std. Dev.*	*Sum*
Y	*16*	*?*	*0.159*	*?*	*399.851*

Solution:

SE Mean = $\sqrt{S^2/N}$

0.159 = $\sqrt{S^2/16}$

$0.159^2 = S^2/16$

S^2 = 0.4045

Std. Dev. $S = 0.636$

Mean = Sum/N = 399.851/16 = 24.99

3. *Suppose that we are testing H0: $\mu = \mu_0$ versus H1: $\mu \neq \mu_0$. Calculate the P-value for the following observed values of the test statistic:*

Solution:

(a) $Z_0 = 2.25$

P-value = $2[1 - \emptyset(|Z_0|)]$ = 2[1-$\emptyset(2.25)$]=2[1-0.987776] = 0.024448 $\approx$ 0.02445

(b) $Z_0 = 2.10$

P-value = $2[1 - \emptyset(|Z_0|)]$ = 2[1-$\emptyset(2.25)$]=2[1-0.982136] = 0.035728 $\approx$ 0.03573

(c) $Z_0 = -0.10$

P-value = $2[1 - \emptyset(|Z_0|)]$ = 2[1-$\emptyset(-0.10)$]=2[1-0.53983] = 0.92034