EMPIRICAL TESTING DOCUMENT

SMART WARNING SYSTEM

(Project no.-9)

Created by :

Group no.-18

Abhishek Kumar (160101007)
Abhishek Ranjan (160101008)
Hemant Yadav (160101034)

Supervised by :
Prof. Samit Bhattacharya

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1. Objective

Empirical research is broadly defined as the observation-based investigation seeking to discover and interpret facts, theories, or laws. It is the collection and analysis of end user data for determining the usability of an interactive system by an observation-based investigation. Empirical research involves the scientific use of quantitative and qualitative data to understand and improve the software product, software development process and software management. It is based on three themes

(1) Raising and Answering testable research questions
(2) Observation and Measurement of variables
(3) User studies

The conduction of empirical study for the smart warning system app is based on these three themes.

2. Brief Description

The app name is Smart Warning System. The app monitors the attention of the students during the ongoing lecture. The professor creates a session that the students join. All the devices are connected to the same wifi network. Use of mobile phones is not allowed inside the class. As soon as the state of a student changes, a notification is sent to that student as well as the professor. The students can see their current report as well report for previous sessions. The professors can see current report of any student during an ongoing lecture as well as the previous report after a session has ended.

3. Testable Research Questions

Q1. For a given course and given slot of lecture, what is the value of total no. of notifications per student received by the professor in a lecture in the following 2 cases ?

(a) When notifications were sent to the professor only for state change to 4 , 7 and 8(New System).

(b) When notifications were sent to the professor for all state changes.(Existing System)

Independent Variables : Course and slot of the lecture

Dependent Variables : Ratio of total no. of notifications received by the professor per student in the given two scenarios present in class.

Slot of lecture	9:00AM TO 10:00 AM 10:00 AM TO 11:00 AM 11:00 AM TO 12:00 PM
Course	CS204 CS222 CS242

Q2. For a given course and given strength of class, what is the ratio of total no. of notifications acted upon by the professor at the end of the lecture to the total no. of notifications sent to the professor in the following two scenarios ?

(a) When notifications were sent to the professor only for state change to 4, 7 and 10. (New System)
(b) When notifications were sent to the professor for all state changes.(Existing System)

Independent Variables : Course and strength of class
Dependent Variables: Ratio of total no. of notifications acted upon in the given two scenarios.

Course	CS204 CS222 CS242
Strength of class	10 30 50

Q3. For a given course and a given slot for that lecture if a student goes to an inattentive state, what is the ratio of following two quantities ?
(a) Total no. of notifications sent for state change into state 4 to
(b) Total no. of notifications sent for any inattentive state change.
in the two scenarios as described below
(a) When state change notification is sent to the student for all states (New System)
(b) When state change notification is sent to the student only for state change into state 4 and 7. (Existing System)

Independent Variables : Course and slot.

Dependent Variables : Ratio of total no. of notifications sent in the two cases.

Course	CS204 CS222 CS242
Slot of lecture	9:00AM TO 10:00 AM 10:00 AM TO 11:00 AM 11:00 AM TO 12:00 PM

Q4. Given that every participant is allowed to see his/her current report n no. of times and given the font size, what is the proportion of errors committed in the following two scenarios

(a) When the current report is put as a button (New System)
(b) When the current report is put as a text (Existing System)

Independent Variable : No. of times participant is allowed to see his/her current report and font size
Dependent Variable : Error ratio in the given two scenarios.

No. of times participant sees his/her current report	1 3 5
Font Size	8mm 14mm

3.1 Justification for Questions

The questions formulated above are internally valid.
The testable research questions formulated above are testable because

(a) The first question checks about the ratio of no. of notifications per student in the two defined conditions, which can be calculated mathematically.

(b) The second question checks about the ratio of no. of notifications acted upon by the professor in specified two conditions, which can also be calculated.

(c) Third question revolves around asking the ratio of notifications sent to the student in the two specified conditions, which is again mathematically computable.

(d) The fourth question is about errors committed in seeing current report by a participant, which is computable quantity.

Also the above formulated questions revolve around the representative task of sending the notification to the professor and the student and seeing the status report of the student whether he/she is attentive or not. Also the given independent variables can compute a reasonably accurate value for the dependent variable concerned.
Since the questions are narrow testable research questions, the outcomes influencing the broader questions are also covered.

(a) Through first question 1, it is ensured that the new system does not create too big a clutter of notifications for the professor and simultaneously keeping check that the professor is always able to determine whether the student is attentive or not.

(b) For question 2, suppose it is found out that the in the new system the proportion of notifications not acted by the professor is less than that in the existing then the new system will be treated as a better system than the current one because in the new system, less notifications would be missed by the professor.

(c) For question 3, suppose that in the new system it is found that the proportion of notifications sent to the student for the state change into state 4 is less than that being sent in the existing app than the new app will called as better functioning because in the new system, a student does not remain inattentive for more than 2 minutes simultaneously.

(d) The last question deals with the user interface. If the error rate is found out less in the new app to see the current report, then the new system will be considered as better than the previous system.

4. Experiment Design

Experiment design in the context of empirical research refers to the organization of variables, procedures, participants, etc in an experiment.

4.1 Procedure for Collecting Data

(a) The participants were first explained the general objective of the experiment.
(b) Then the app was launched and the control handed over to the participants.

(c) The participants were allowed to explore the app for a while for familiarization.
(d) The collection of data was initiated after this.
(e) In total 9 observations were collected for the each question.

4.2 User Details

Users are college students in the age group 17 to 21 years of age and college professors.

4.3 Control Variables

Control variables are Factors that might influence a dependent variable, but are not under investigation need to be accommodated in some manner.

For this app following are control variables:
(a) Screen resolution
(b) Background Picture
(c) Font color

4.3 Dependent and Independent Variables

Dependent Variables	**Independent Variables**	**Levels**
Ratio of total no. of notifications per student received by the professor in the two scenarios described in research question Q1	Slot of the lecture Course	9:00AM TO 10:00 AM 10:00 AM TO 11:00 AM 11:00 AM TO 12:00 PM CS204 CS222 CS242
Ratio of total no. of notifications acted upon in the two scenarios defined in question Q2.	Course Strength of class	CS204 CS222 CS242 10 30 50

Ratio of total no. of notifications sent in the two cases defined in question Q3	Slot of the lecture Course	9:00AM TO 10:00 AM 10:00 AM TO 11:00 AM 11:00 AM TO 12:00 PM CS204 CS222 CS242
Error ratio in the given two scenarios described in question Q4	No. of times participant is allowed to see his/her current report Font Size	1 3 5 8mm 14mm

4.4 Design Specifications

The four dependent variables used above are coded as-

Total no. of notifications per student received by the professor in the two scenarios described in research question Q1	D1
Total no. of notifications acted upon in the two scenarios defined in question Q2.	D2
Total no. of notifications sent in the two cases defined in question Q3	D3
Error ratio in the given two scenarios described in question Q4	D4

The design specifications for the described 3 dependent variables are as follows-

(a) **D1:** A(3*3) Between subjects design has been employed so each participant has been tested on only one level of each independent variable. A(3*3) means that this dependent variable has 2 independent variables one with 3 levels and the other also with 3.

(b) **D2:** A(3*3) Again between subjects design has been employed. This dependent variable also has 2 independent variables associated with it one with 3 levels while other also with 3.

(c) **D3:** A(3*3) Between subjects design has been employed. This dependent variable also has 2 independent variables associated with it one with 3 levels while other also with 3.

(d) **D4 :** A(3*2) Between subjects design has been employed. This dependent variable also has 2 independent variable associated with it with 3 levels associated with first variable and 2 with the second.

5. Data Tables

5.1 For variable D1

Participant	Slot of lecture	Course	Value of D1 (New System)	Value of D1 (Existing System)
1	9:00 AM to 10:00 AM	CS204	4.0	10.0
2	9:00 AM to 10:00 AM	CS222	6.0	20.0
3	9:00 AM to 10:00 AM	CS242	5.0	15.0
4	10:00 AM to 11:00 AM	CS204	2.0	8.0
5	10:00 AM to 11:00 AM	CS222	6.0	16.0
6	10:00 AM to 11:00 AM	CS242	4.0	10.0
7	11:00 AM to 12:00 AM	CS204	3.0	8.0
8	11:00 AM to 12:00 AM	CS222	8.0	14.0

9	11:00 AM to 12:00 AM	CS242	4.0	10.0

5.2 For Variable D2

Participant	Course	Strength of class	Value of D2 (New System)	Value of D2 (Existing System)
1	CS204	10	1.00	1.00
2	CS222	10	0.82	0.90
3	CS242	10	0.94	0.96
4	CS204	20	0.74	0.82
5	CS222	20	0.42	0.76
6	CS242	20	0.64	0.80
7	CS204	50	0.46	0.66
8	CS222	50	0.22	0.54
9	CS242	50	0.10	0.60

5.3 For Variable D3

Participant	Slot of Lecture	Course	Value of D3 (New System)	Value of D3 (Existing System)
1	9:00 AM to 10:00 AM	CS204	0.10	0.20
2	9:00 AM to 10:00 AM	CS222	0.42	0.52
3	9:00 AM to 10:00 AM	CS242	0.20	0.16
4	10:00 AM to 11:00 AM	CS204	0.01	0.01
5	10:00 AM to 11:00 AM	CS222	0.40	0.34
6	10:00 AM to 11:00 AM	CS242	0.22	0.20
7	11:00 AM to 12:00 AM	CS204	0.10	0.10
8	11:00 AM to 12:00 AM	CS222	0.58	0.54
9	11:00 AM to 12:00 AM	CS204	0.24	0.20

5.4 For Variable D4

Participant	No. of times participant is allowed to see his/her current report	Font size (in mm)	Value of D4 (New System)	Value of D4 (Existing System)
1	1	8	0.60	0.80
2	1	14	0.60	0.76
3	3	8	0.22	0.32
4	3	14	0.20	0.30
5	5	8	0.12	0.14
6	5	14	0.06	0.08

Grand Mean	1.83

6. ANOVA Calculation

6.1 Steps of ANOVA

(a) From above data, calculate total sum of squares by the formula

(i) $SS_T = \Sigma(x_i - mean_{grand})^2$

x_i is the error rate value of the i-th participant (among all)

(ii) Degree of freedom = number of things used to calculate – 1

(b) Next step is the calculation of SS_M i.e. model sum of squares which is calculated using the following steps

– Calculate ($mean_{group\_i} - mean_{grand}$) for the i-th group
– Square the above
– Multiply by n_i, the number of participants in the i-th group
– Sum for all groups

(c) Residual Sum of Squares denoted as SS_R is calculated as

$SS_R = SS_T – SS_M$

and corresponding degree of freedom is calculated as follows

DoF (SS_R) = DoF (SS_T) – DoF (SS_M)

(d) Model Mean Square = $MS_M = SS_M/DoF(SS_M)$

(e) Residue Mean Square = $MS_R = SS_R/DOF(SS_R)$

(f) F ratio = MS_M/MS_R

DoF associated with F-ratio are the DoFs used to calculate the two mean squares [that is DoF(SS_M) and DoF(SS_R)]

(g) Next step is to look in the table for the expected value of F in the table

The critical values signifies the value of F that we would expect to get by chance for α% of test.

6.2 Calculation for Variable D1

Factor	New System	Existing System
Mean	4.66	12.33
Sample Standard Deviation	1.80	4.12
Sample Standard Variance	3.25	17.00

SS_T = 1227.30
DoF(SS_T) = 17

SS_M = 354.77
DoF(SS_M) = 1

SS_R = 1227.30 - 354.77
= 872.53
DoF(SS_R) = 17 - 1
= 16

MS_M = 354.77

MS_R = 54.53

F ratio = 6.52

F ratio can be written as
F(1, 16) = 6.52

Expected F(1, 16) = 4.49 = critical value

Clearly F(1, 16) = 6.52 > critical value implies that the effect of test conditions has a significant effect on the outcome w.r.t. $\propto$..
So, new method has a significant effect on reducing user errors [F(1,16)=6.52, p<.05] compared to the other methods.

6.3 Calculation For Variable D2

Factor	**New System**	**Existing System**
Mean	0.59	0.78
Sample Standard Deviation	0.31	0.16
Sample Standard Variance	0.10	0.02

SS_T = 24.63
DoF(SS_T) = 17

SS_M = 7.92
DoF(SS_M) = 1

SS_R = 24.63 - 7.92
= 16.71
DoF(SS_R) = 17-1
= 16

$MS_M = 7.92$
$MS_R = 1.04$

F ratio = 7.54

F can be written as
$F(1, 16) = 7.54$

Critical Value = 4.49

Clearly $F(1, 16) = 7.54 >$ critical value implies that the effect of test conditions has a significant effect on the outcome w.r.t. $\propto$..
So, new method has a significant effect on reducing user errors [$F(1,16)=7.54$, $p<.05$] compared to the other methods.

6.4 Calculation For Variable D3

Factor	New System	Existing System
Mean	0.25	0.25
Sample Standard Deviation	0.18	0.18
Sample Standard Variance	0.03	0.03

SS_T = 45.33
DoF(SS_T) = 17

SS_M = 14.97
DoF(SS_M) = 1

SS_R = 47.36
DoF(SS_R) = 16

MS_M = 14.97
MS_R = 2.90

F ratio = 5.16

F ratio can be written as
F(1, 16) = 5.16

Critical Value = 4.49

Clearly F(1, 16) = 5.16 > critical value implies that the effect of test conditions has a significant effect on the outcome w.r.t. $\propto$.

So, new method has a significant effect on reducing user errors [F(1,16)=5.16, p<.05] compared to the other methods.

6.5 Calculation For Variable D4

Factor	New System	Existing System
Mean	0.30	0.40
Sample Standard Deviation	0.24	0.31
Sample Standard Variance	.06	0.09

SS_T = 27.08
DoF(SS_T) = 11

SS_M = 13.16
DoF(SS_M) = 1

SS_R = 23.92
DoF(SS_R) = 10

MS_M = 13.16
MS_R = 2.39

F ratio = 5.50

F ratio can be written as
F(1, 11) = 5.50

Critical Value = 4.84

Clearly F(1, 16) = 5.50 > critical value implies that the effect of test conditions has a significant effect on the outcome w.r.t. $\propto$.
So, new method has a significant effect on reducing user errors [F(1,16)=5.50, p<.05] compared to the other methods.