Empirical Research Document:

FOR

STUDENT ACTIVITY DETECTOR AND ALERT GENERATION APP FOR INSTRUCTOR

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Date – 6/05/2017

Empirical research:

Empirical research is broadly defined as the observation-based investigation seeking to discover and interpret facts, theories, or laws. Collection and analysis of end user data for determining usability of an interactive system is an "observation-based investigation", hence it qualifies as empirical research
It is not sufficient to simply observe and conclude, it is also necessary to theorize about the observations. The direct conclusions from observations help us decide an interaction method; a theory about observed behaviour can help us do much more. Such theories can eliminate need for further investigations as well as can suggest ways for improvement
The meaning of empirical is: based on, concerned with, or verifiable by observation or experience rather than theory or pure logic.
The three themes of empirical research are
– Answer and raise questions (testable research questions)
– Observe and measure (ratio scale of measurement is preferable)
– User studies

Conducting an empirical research consists of following steps:
1). forming testable question.
2). Designing experiments
3). Observing the data
4). Making statistical significance report

Research questions:

It is very important in an empirical research to formulate "appropriate" research questions. For very specific questions, the accuracy of answers is high whereas for broader questions, the breadth or generalizability is high. So We have to come-up with testable questions in empirical research.

Example:
Q). Do you find any other anomaly or background disturbances while the lecture was running and will you use it to attend lectures instead of taking a normal regular class?

Q). Within how many minutes do you think a user who knows about using android smart phone can understand the functionality of the app as compared to other educational apps?

Experiment Design:

Experiment design is a general term referring to the organization of variables, procedures, etc., in an experiment. The process of designing an experiment is the process of deciding on which variables to use, what procedure to use, how many participants to use, how to solicit them etc. Terms to know are Participant, Independent variable (test conditions), Dependent variable.

Participant:

The people participating in an experiment are referred to as participants

Independent variable:

An independent variable is a variable that is selected or controlled through the design of the experiment. The terms independent variable and factor are synonymous.

Dependent Variable:

A variable representing the measurements or observations on a independent variable.

Statistical significance:

It is important to note that the term "significance" is a statistical term.
The test of (statistical) significance is an important aspect of empirical data analysis
We can use statistical techniques for the purpose – The basic technique is ANOVA or Analysis of variance.

Empirical Approaches: Surveys

Initiate:

Pose questions via interviews or questionnaires

Process:

Select variables and choose sample, frame questions that relate to variables, collect data, analyse and generalize from data

Uses:

Descriptive (assert characteristics), explanatory (assess why), exploratory (pre-study)

Participant details:

for q1 and q2

NO.	AGE	BACKGROUND	TECHNICAL KNOWLEDGE
participant 1	16	School student	Intermittent
participant 2	14	Village school student	Novice
participant 3	21	A technical enthusiast and college student	Expert
participant 4	23	College student	Intermittent
participant 5	20	A developer	Expert

Question 1:

Is the interface simple enough and easy so that a 10-year-old can use or even a first time android smart phone user can learn, if yes then in how many days would they learn it?

Explanation to be given: Explaining the interface structure, screen and visual layouts and various functionalities and how to achieve them.
Independent variable involved: Expertise, Educational background, screen layout
Dependent variable involved: leaning time (days)

Suppose,
Participant 1 will learn in 2 days of use.
Participant 2 will learn in 1 days of use.
Participant 3 will learn in 2 days of use.
Participant 4 will learn in 2 days of use.
Participant 5 will learn in 3 days of use.

	Days taken to learn
Participant 1	2
Participant 2	1
Participant 3	2
Participant 4	2
Participant 5	3

So average time that a first-time android smart phone user will take to learn this system is :(2 +1 + 2 + 2 + 3)/5
=2 days
Conclusion made: On an average it would take 2 days for a technically unaware student to learn the new system.

Question 2:

Within how many minutes do you think a user who knows about using android smart phone can understand the functionality of the app as compared to other educational apps (a specific app)?

Explanation to be given: Explaining the interface structure, screen and visual layouts.
Independent variable involved: Technical expertise, visual layout
Dependent variable involved: learning time (minutes)

Suppose,
Participant 1 will take 15 minute to understand our system and 20 minute to understand the other one.
Participant 2 will take 10 minute to understand our system and 10 minute to understand the other one.
Participant 3 will take 20 minute to understand our system and 15 minute to understand the other one.
Participant 4 will take 5 minute to understand our system and 10 minute to understand the other one.
Participant 5 will take 5 minute to understand our system and 10 minute to understand the other one.

	Our system	Other system
Participant 1	15	20
Participant 2	10	10
Participant 3	20	15
Participant 4	5	10
Participant 5	5	10

So average time the user will take to learn our system is :(15 +10 + 20 + 5 + 5)/5
=11 minute
So average time the user will take to learn other system is :(20 +10 + 15 + 10 + 10)/5
=13 minute

We can use statistical techniques for the purpose
– The basic technique is ANOVA or analysis of variance
Grand mean = (11 + 13)/2 = 12
Grand standard deviation = 15.8
Grand variance = 250

	Our system	Other system
MEAN	11	13
STANDARD DEVIATION	5.8	4
VARIANCE	34	16

D.O.F = Degree of freedom
Calculate "total sum of squares (SS_T)":
$SS_T = \sum (x_i - \text{mean-grand})^2$ where, x_i is the error rate value of the i-th participant (among all)
$SS_T = ((15-12)^2 + (20-12)^2 + (10-12)^2 + (10-12)^2 + (20-12)^2 + (15-12)^2 + (5-12)^2 + (10-12)^2 + (5-12)^2 + (10-12)^2) = 260$
$DOF (SS_T) = 10$

Calculate the "model sum of square (SS_M)"
$SS_M = \sum (\text{mean-group}_i - \text{mean-grand})^2$ where, mean-group_i is the mean of the i-th group
$SS_M = 5(11-12)^2 + 5(12-13)^2 = 10$
$DOF (SS_M) = 1$

Calculate the "residual sum of square (SS_R)" and the corresponding DoF
$SS_R = SS_T - SS_M = 250$
$DOF (SS_R) = DOF (SS_T) - DOF (SS_M) = 9$

Calculate two "average sum of squares" or "mean squares (MS)"
• Model MS (MS_M) = $SS_M/DOF(SS_M) = 10$
• Residue MS (MS_R) = $SS_R/DOF(SS_R) = 27.8$

Calculate the "F-ratio" is $MS_M / MS_M = 10/27.8 = 0.36$
Thus, we get critical value = 5.22 for F (1,9), α=.05

Conclusion made: Note that F (1, 9) =0.36 < the critical value – Implies that the effect of test conditions does not has significant effect on the outcome w.r.t. α.

Question 3:

Here the participants are instructors.
If error rates are kept under 5%, do you find the activeness state that was reported is acceptable and were you confident enough in using it to give a whole lecture in a large class, if yes then how much of time will you use it?

Participant details:

NO.	AGE	BACKGROUND	TECHNICAL KNOWLEDGE
participant 1	40	School teacher	Intermittent
participant 2	50	Village school teacher	Novice
participant 3	42	A technical enthusiast and college lecturer	Expert
participant 4	38	College professor	Intermittent
participant 5	45	Interactive teacher and technically strong	Expert

Explanation to be given: Explaining the interface structure, screen and visual layouts, various functionalities and how to achieve them. Specifically, how the app helps to monitor the whole class.
Independent variable involved: Device system, Task, usage
Dependent variable involved: use percentage timings (%)

Suppose,
Participant 1 will use this system 80 % of time.
Participant 2 will use this system 40 % of time.
Participant 3 will use this system 60 % of time.
Participant 4 will use this system 90 % of time.
Participant 5 will use this system 100 % of time.

	Percentage of time used
Participant 1	80
Participant 2	40
Participant 3	60
Participant 4	90
Participant 5	100

So *average time that instructor will use this system* is: (80 + 100 + 60 + 90 + 40)/5 =74%

Conclusion made: On an average instructor would use this system 74% of their time for delivering the course.