

Submitted By

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## **Introduction :**

Empirical study is the collection and analysis of end user data for determining the usability of an interactive system by an observation-based investigation. It is based on three themes:

- Raising and Answering Questions (Testable research questions)
- Observation and Measurement of variables
- User studies

The conduction of empirical study for the Game based learning App system is based on these three themes.

## **1. Research Questions**

Research questions help in testing the usability of the system. It can also help in comparing the performance like speed, learnability of a system with respect to an existing system. The existing system used for comparison with our system is a similar game-based sorting app developed on an Android platform.

A brief description :

### **• Existing System:**

**App :** Sorting Algorithms

**Description :** This app provide the users/students with a mobile app through which the user will be able to increase their extent of understanding about the algorithm and therefore can improve

their clarity about these concepts. This app will help them understand the sorting algorithms like Insertion sort, Quick sort and Bubble sort in a more efficient way which is in a game based learning platform.

- **Research Questions:**

**Q1.** For a given no of restarts, sorting algorithm type and number of array elements, what is the time taken to sort?

Independent Variables : NoOfRestarts, NoOfElements, SortingAlgorithmType.

Dependent Variables : SortingTime

Factors	Levels
NoOfRestarts	1, ..., 10
NoOfElements	1, ..., 10
SortingAlgorithmType	1, 2, 3

**Q2.** Given the moves made by the user, number of array elements, sorting algorithm type what is the Score of the user?

Independent Variables :  
MovesMadeByUser, NoOfElements, ScreenSize, SortingAlgorithmType.

Dependent Variable : ScoreOfUser

Factors	Levels
MovesMadeByUser	1, 2, 3
NoOfElements	1, ..., 10
SortingAlgorithmType	1, 2, 3

- **Validity Of Research Questions:**

The research questions formulated are internally valid (Greater Focus on Test Conditions)

Q1: The given Independent variables can compute a reasonably accurate value for the measure of *SortingTime*

Q2: The given Independent variables can compute a reasonably accurate value for the measure of *ScoreOfUser*

Since the questions are narrow testable research questions, the outcomes influencing the broader questions are also covered.

## 2 . Experiment Design

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

### Experiment Objectives:

The experiment is designed in order to pre-decide on the number and category of participants to be involved, the apparatus to be used and the procedure to be followed for collecting data and categorization of variables.

### Participants:

Twenty participants are employed for empirical study.

S.N o	AGE	Gender	Background	Android Experience	Programming Experience
1	18	M	S	2	1

2	19	M	S	3	3
3	20	F	S	1	3
4	18	M	S	2	2
5	19	F	S	3	2
6	18	M	S	1	3
7	17	F	NS	3	3
8	20	F	S	1	2
9	21	F	NS	2	1
10	35	M	NS	3	3
11	25	F	S	1	2
12	31	F	NS	3	3
13	18	F	S	3	1
14	28	M	NS	2	3
15	29	F	NS	2	2
16	19	F	S	3	3
17	20	F	S	2	1
18	25	M	NS	1	3
19	22	M	S	2	3
20	23	M	S	1	2

S- STUDENT

ANDROID EXPERIENCE : BASIC-1, INTERMEDIATE-2,  
ADVANCED-3

PROGRAMMING EXPERIENCE : BASIC-1, INTERMEDIATE-2,  
ADVANCED-3

### **Procedure For Collecting The Data:**

- The participants were first explained the general objective of the Experiment.
- Then the app was launched and the control handed over to the participants.
- The participants were shown “How to search a query” interactive tutorial.
- The participants were shown “How to navigate” interactive tutorial
- The participants were allowed to explore the app for a while for familiarization
- The collection of data was initiated after this.
- Each participant was allowed to search the query 1 times.
- Each participant was allowed to navigate through all the models.
- In total 10 observations were collected for the first question.
- In total 10 observations were collected for the second question.

### **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:

- Game Volume
- Background Picture
- Time between
- Screen Resolution

### **Independent and Dependent Variables**

The sorting algorithm type and moves made by user are encoded as :

- 1- Bubble Sort
- 2- Insertion Sort
- 3- Selection Sort

Dependent Variables	Factors	Levels
SortingTime	NoOfRestarts	1, ..., 10
	SortingAlgorithmType	1, 2, 3
	NoOfElements	1, ... , 10
ScoreOfUser	MovesMadeByUser	1, 2, 3
	NoOfElements	1, ... , 10
	SortingAlgorithmType	1, 2, 3

### **Design Specifications:**

the design specifications for the two dependent variables are as follows:

1. SortingTime: A (10 x 4 x 10) between subjects design has been employed. This means that we have 3 independent variables with 10 levels for the first, 4 for the second, and 10 levels for the third independent variable, and each participant

has been tested on only one level of each independent variable (between subjects design)

2. ScoreOfUser:A (6 x 7x 10) between subjects design has been employed. This means that we have 3 independent variables with 6 levels for the first, 7 for the second, and 10 levels for the third independent variable, and each participant has been tested on only one level of each independent variable (between subjects design)

### **Data Tables:**

For SortingTime:

Participant	NoOfRestarts	SortingAlgorithm Type	NoOfElements	SortingTime
1	2	2	10	4
2	1	2	9	3
3	2	1	8	3
4	4	2	8	6
5	3	2	9	5
6	5	1	8	6
7	5	2	8	8
8	1	3	9	4
9	3	1	9	5
10	2	1	8	4
11	2	2	10	5
12	2	1	10	4
13	1	2	8	6
14	2	3	8	4
15	2	3	10	3
16	1	1	8	3
17	2	1	9	6
18	3	1	8	5
19	1	3	8	6
20	1	2	9	4

For ScoreOfUser:

Participant	MovesMadeByUser	SortingAlgorithmType	NoOfElements	Score
1	2	2	10	60
2	1	1	9	80
3	2	2	8	40
4	3	2	8	50
5	3	1	9	40
6	1	2	8	50
7	1	3	8	40
8	1	3	9	40
9	3	2	9	50
10	2	1	8	40
11	2	2	10	50
12	2	2	10	40
13	1	3	8	60
14	2	3	8	40
15	2	3	10	60
16	1	1	8	50
17	2	2	9	40
18	3	2	8	50
19	1	1	8	40
20	1	2	9	40



**Result**

For SortingTime:

Sample Standard Deviation	1.3416407864999
Variance (Sample Standard)	1.8
Total Numbers (N)	20
Sum	94
Mean (Average):	4.7

For ScoreOfUser:

Sample Standard Deviation	10.563093645728
Variance (Sample Standard)	111.57894736842
Total Numbers(N)	20
Sum	960
Mean (Average)	48