DEVELOPMENT OF WEB-BASED/E-LEARNING ON DESIGN OF EXPERIMENT TECHNIQUE; CASE OF RANDOMIZED COMPLETE BLOCK DESIGN (RCBD)

Oleh

NOR ILYANA BT. MUHD. NORDIN

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SARJANA MUDA KEJURUTERAAN (KEJURUTERAAN ELEKTRONIK)

Pusat Pengajian Kejuruteraan
Elektrik dan Elektronik
Universiti Sains Malaysia

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ABSTRACT

In research and development, often half of the resources are spent on solving optimization problems. With the rapidly rising costs of making experiments, it is essential that the optimization is done with as few experiments as possible. This is one important reason why *Design of Experiments* (DOE) is needed. In certain field there are circumstances in which the experimenter would like to screen factors to decide which are the most important. In these situations the engineering model of DOE is useful. These all signify the importance of DOE. *Randomized Complete Block Design* (RCBD) and *Latin Square Design* are DOE blocking techniques. This project has a vision of educating its viewer through a different environment of learning the subject of RCBD and Latin Square Design. Materials are explored from various resources that can be found in books and in the internet just to ensure the webpage provide sufficient and refer to reliable information. It proved that the materials included in the webpage combines all resources so that the webpage is ensured to cover entire concept behind both topics. With interactive links to relate one slide to the other, viewers are directed clearly from one page to the other until they have covered the whole topics in RCBD and Latin Square Design that stated in the research scope. Besides, there are also sections to test the understanding of the viewer that are named after “Do It Yourself”. In this section, complete solutions are provided for each problem, so that the viewer can check their solution with the solutions provided in the webpage. Other than learning, there are also slides provided for relaxations that are named after “Take 5”. These slides provide refreshment for viewers because its contents can lighten up their mind. Moreover, the overall structure of the webpage is well organized and viewers are ensured not to getting lost while surfing the webpage. The whole webpage design, development and its content are arranged in a way that is hoped to facilitate and add up to viewers’ awareness of the concept behind the application of RCBD and Latin Square Design. Above all, the webpage is expected to give new and clear lessons for those who are not familiar with the subject and also add up to current knowledge of the subject for those who familiar with the subject. It is also hoped that the webpage can be recommended as one of the useful resources for RCBD and Latin Square Design.

ABSTRAK

Dalam kajian dan pembangunan, seringkali separuh dari pendapatan dilaburkan bagi menyelesaikan masalah-masalah pengoptimuman. Dengan peningkatan kos eksperimen, adalah sangat penting jika pengoptimuman dilakukan dengan bilangan eksperimen yang sedikit. Ini adalah salah satu sebab Rekabentuk Eksperimen (DOE) adalah sangat diperlukan. Dalam sesetengah bidang, terdapat keadaan yang mana pengeksperimen ingin mengkaji factor-faktor yang mempengaruhi proses. Dalam kes seperti inilah aplikasi model kejuruteraan DOE amat berkesan. Kesemua ini menunjukkan bahawa DOE adalah sangat membantu. *Randomized Complete Block Design* (RCBD) dan *Latin Square Design* (LSD) adalah dua jenis teknik rekabentuk blok dalam DOE. Visi projek ini ialah mendedahkan pengunjung kepada subjek RCBD dan LSD melalui persekitaran pembelajaran yang berbeza Bahan-bahan yang dimuatkan adalah daripada pelbagai sumber, sama ada buku mahu pun internet. Ini bagi memastikan laman web ini memuatkan bahan-bahan yang mencukupi dan boleh dipercayai dan juga supaya laman web ini meliputi keseluruhan konsep disebalik kedua-dua topik. Melalui *penghubung(link)* yang interaktif untuk menghubungkan kesemua laman di dalam laman web ini, penunjung diarah dengan jelas daripada satu laman ke laman yang lain. Tambahan lagi, terdapat laman yang dibina khas untuk menguji kefahaman pengunjung terhadap kandungan laman web ini. Iaitu laman ‘Do It Yourself’. Yang mana penyelesaian bagi setiap soalan turut disertakan. Selain pembelajaran, terdapat juga laman di dalam laman web ini yang menghiburkan pengunjung. Iaitu laman “Take 5”. Kandungan laman ini dipercayai akan menyegarkan kembali para pengunjung selepas mengikut bahagian RCBD dan LSD. Keseluruhan struktur laman web adalah tersusun dan tidak memungkinkan pengunjung untuk tersesat. Rekabentuk, pembangunan dan kandungan keseluruhan laman web disusun bagi membantu dan menambah pengetahuan yang sedia ada tentang RCBD dan LSD. Namun yang penting, laman web ini dipercayai mampu memberi pengetahuan yang jelas kepada pengunjung sama ada yang sedia tahu mengenai DOE atau pun tidak Laman web ini juga diharap dapat dicadangkan sebagai salah satu daripada sumber bermanfaat bagi mempelajari topik RCBD dan LSD.

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1.1 STRUCTURE OF THESIS

It is vital to have a well structured thesis to clearly explain the entire task regarding the whole project. This is not just because we want a good representation of our work but also to benefit the mankind by getting a clear perception on what we are trying to expose. Further study on the project can be carried out if our work has successfully proved the importance of the project. Therefore, the thesis of this project is divided into six chapters excluding reference and appendix so that the thesis can be observed systematically.

1.1.1 CHAPTER 1: INTRODUCTION

This chapter contains the structure of thesis, problem statement, objectives and research scope. Which is in structure of thesis, the overview of each chapter in the entire thesis is described. Whereas in problem statement, all the reasons why the project is been carried out is clarified. Then in slot for objectives, the goals and aims that are wished to accomplish is listed. While in research scope, all the material that must be in the project is listed and explained thoroughly.

1.1.2 CHAPTER 2: LITERITURE REVIEW

This chapter will clarify about various research and findings that have been done on *Design of Experiment (DOE), Randomized Complete Block Design (RCBD), Latin Square Design(LSD),* Statistical Analysis Software, Mapping Techniques, Web Editors, definition of good quality webpage designs, current website approach on *RCBD* and *LSD* for websites that are available in the internet and also topics on i-QUEST (QUALITY ENGINEERING SYSTEM RESEARCH GROUP).

1.1.3 CHAPTER 3: PROJECT PHASES

There are two sub chapters in chapter 3 which is chapter 3.1 and 3.2.Section 3.1 will discuss in great detail on the web material presentation, structure of the whole slides in the webpage, about the textual approach, backgrounds used, regarding the navigations bar (links) that is provided, sounds, animations set up and also graphics that are included in the webpage. Section 3.1.2 and 3.1.3 covers on web material presentation and the webpage site map. Section 3.2 will enlighten on feedback content and design. Which is in design section will explain about list of questionnaires to ask to the respondent, the target respondent to view the webpage and the structure of the feedback form. Other than that, this section also includes clarification on testing and evaluation which had been done on the webpage and also modification which had been carried out to improve the performance of the webpage after every test is performed.

1.1.4 CHAPTER 4: RESULTS AND ANALYSIS

This chapter will reveal all the outcomes from the webpage presentation. Analysis is done on each questionnaire that is asked to all respondent to find the weakness part of the webpage. From this chapter, improvement and recommendation can be proposed and carried out.

1.1.5 CHAPTER 5: FUTURE WORK AND RECOMMENDATION

This chapter elaborates in detail about future work and recommendation. In which, for future work, webpage enhancement can be done to upgrade webpage content or even to change other part of the webpage that is felt not suitable. Whereas in recommendation section, by referring to the outcome of this project, various recommendations will be outlined for improvement of the project in the future.

1.1.6 CHAPTER 6: CONCLUSION

This chapter contains conclusion to recap all contents in the whole project and thesis and also to reemphasize on the benefits of the project.

An efficient and well organized thesis is believed to be very helpful to educate those who interested to learn more about a certain task without experiencing the essence of the project itself whether it is software or a system or it is a webpage. Therefore, the content as well as the presentation of this thesis is expected to meet the criteria of a well structured thesis for it will acquaint with the viewer perception of the presentation of the webpage content. Besides, it is hopeful that the thesis will verify the importance of this project.

1.2 PROBLEM STATEMENT

Nowadays, almost everybody regardless of where we are have the accessibility to the internetworking. Internetworking is no longer a rare occasion. Therefore, application of e-learning in various field of study is basically practical and acknowledgeable. Here, we are discussing about *Randomized Complete Block Design (RCBD), Latin Square Design (LSD*) and *Design of Experiment (DOE).* Anybody who is interested to know in detail about these three subjects will have their full accessibility to read about them from various books that can be found in bookstores, in the library, or even they can surf the material through sources that are provided in the websites that are published in the Internet. Unfortunately, whether the sources are from books or from the Internet, the way the author presents the material is basically the same. Which is very long-winded, verbose, wordy, and in long paragraphs. It is hardly to see any diagrams or even mapping techniques use to simplify the concept in the materials. We can only see graphs, table and paragraph after paragraph for elaboration about the subject.

Thus, this website is built together with the vision of overcoming the following short comes:

1. Reading books are boring and too passive. Sometimes as a student, we need a fresh surrounding to generate and maintain our mood to study.
2. Existing websites on *RCBD* and *LSD* are just as boring as books yet they are still very informative.
3. Explanations are written in long-winded paragraph and very wordy.
4. Less application of diagrams to simplify the main idea behind the intended topics.
5. No websites about *RCBD* and *LSD* on the Internet that applies mapping techniques to deliver its content.
6. At times that we have to study on *RCBD* and *LSD* but we cannot or did not bring our books or sources about the subject but there exist internetworking facilities.
7. No Malaysian made website on *RCBD* and *LSD* can be found on the internet. Every single website that we surfed on the Internet is non-Malaysian made.

To overcome the problems stated above, the website provides the viewer with the changes that is stated as below:

- No long paragraphs for explanations.
- Ninety percent (90%) of the whole content of the website material is presented using concept or mind mapping approach and other diagrams. Even the webpage itself is a concept map.
- Viewer is directed clearly to pages comprised in the website. Every page has their own button or icon for links or navigations[1].
- Questions and solutions to problems given and steps to tackle the questions are provided.
- Despite of learning through the website, viewer can also browse to the relaxing section provided within the website.
- The interfaces [2]used are very friendly and viewer can easily figure it out when an icon [3]is a button or a link [4]to another page.
- Viewer is guaranteed to easily surf and get as much knowledge that they can from the website without worrying to get lost in the middle of the process.

We have discussed on the conventional way of learning and what a web based e-learning approach can do to deal with all the problems above. Thus, we can jump to the conclusion that building a web based e-learning methods is a good solution to the stated problems. Every project or mission must have its own objective that is hoped to achieve at the end of the session and the same applies to this project. Next chapter will discuss in more detail about the objective of the project.

[1] A way of connecting a page to the other
[2] Presentation of connection between a page to the other
[3] A symbol (words or flash buttons etc) that when point to with cursor will give the viewer an instruction.
[4] Connections between pages.

1.3 OBJECTIVE

This project is stated among a few other projects under i-QUEST (refer Appendix XIV).This project is constructed with a vision to accomplish the objectives stated as below:

- ✓ To change the source of learning '*Design of Experiment (DOE): Case of Randomized Complete Block Design (RCBD)* and *Latin Square Design (LSD)*' from reading books to e-learning (web based materials).
- ✓ To realized the hypothesis that concept or mind mapping method of training on 'DOE: Case of RCBD and LSD' are more effective.
- ✓ To replace the conventional approach of learning by using mapping techniques.
- ✓ To develop a new method of learning which is more practical and less time consuming.
- ✓ To create a different environment of learning 'DOE: Case of RCBD and LSD'.
- ✓ To create a Malaysian made website on the subject of 'DOE: Case of RCBD and LSD'.

Since the project is under i-QUEST, the objective of i-QUEST that related to the project has also been considered while accomplishing this project. Below are listed the objective of i-QUEST:

- ✓ To disseminate the research findings to the local manufacturing companies via the World Wide Web

Thus, from all the objectives that are acknowledged above, it is very hopeful that all of it will be achieved at the end of the project. This is not only to get a good score on the project itself but the main idea is to facilitate the mankind on a new approach of learning the subject. This is because a different method used is believed to generate different perception on the same subject. For that reason, this approach of web based/ e-learning that applies mapping techniques is hoped to change the perception and generate more interest in learning the subject of *RCBD* and *LSD*. Chapter 1.4 will explain in more detail on the scope that the project covers.

1.4 RESEARCH SCOPE

Here, we will outline the scope that must be fully covered in order to ensure that the objectives stated in chapter 1.3 are achieved successfully. According to meetings and discussions, this project has been assigned to the task of building a webpage focusing on the topic of *Randomized Complete Block Design (RCBD)* and *Latin Square Design (LSD)*. To make discussion among group members easier, the main reference have been standardized. The main source is a book by Douglas C. Montgomery, titled "*Design and Analysis of Experiment*" (5th edition, 2001). Referring to this book, topics on *RCBD* and *LSD* are included in Chapter 4. The webpage should comprise basic theories, clear conceptual explanation, examples and questions to make the materials on those two topics more comprehensive. Yet, building an interactive and informative webpage instead of application of mapping techniques where pertinent are the main intention. This is related to what is subjected in the Problem Statement Chapter. Besides, this is the main rationale behind the insight of creating the webpage.

After a few discussions that have been carried out, there are additional materials that is believed will be useful and have to be added into the webpage. Those are listed as below:

Additional items for websites:

i. model adequacy checking
ii. multiple comparison
iii. SPSS printouts
iv. ANOVA Table
v. Residual Plot (Model Adequacy Checking)

As clarified during the group discussion, we have agreed to the same conclusion on the hypothesis. Research hypotheses for the group are acknowledged as below:

$\mathbf{H_0}$: Current training method on DOE is **ineffective** (low rate of application).

$\mathbf{H_a}$: Concept/mind maps method of training on DOE are **more effective** (alternative).

At the end of this project, after the outcome has been revealed, the group will draw the conclusions by referring back to the analyzed data from feedback form that had been filled by few selected respondent and the stated hypothesis. It is very hopeful that we can conclude on the alternative hypothesis. As part of the task, review has been done on the internet to have a better observation on the current webpage approach on the subject of RCBD and LSD and also other chores to be done to complete the project. Chapter 2, on Literature Review will reveal the entire collection from the outcome of the observation.

INTRODUCTION

This Chapter will reveal all outcome of observations that had been carried out on Design of Experiment DOE), focusing on Blocking Design that comprises Randomized Complete Block Design (RCBD) and Latin Square Design, on Statistical Analysis Software, Mapping Techniques, Web Editors, Quality Webpage Definitions and existed Webpages on RCBD and Latin Square Design. Further information on certain sections are provided in Appendix.

2.1 DESIGN OF EXPERIMENT

Experiments provide an efficient way of learning as long as they are properly designed and analyzed. Because all experimental observations are subject to random error, an efficient design and analysis of experiments requires statistical methods. In the last couple of decades, experimental design has become increasingly popular in quality engineering. It is used in nearly any field of stuffy. Scientist and engineers often conduct experiments and investigations to determine laws and models governing a process. This is because, in a process there might be more than one factor that affect the response of the whole process. Design of Experiments (DOE) is an off line quality improvement methodology that dramatically improves industrial products and processes. Input factors are varied in a planned manner to optimize output responses with minimal variability. DOE is a structured, organized method for determining the relationship between factors, affecting a process and the output of the process. DOE assist the experimenter to separate the affecting factors by properly planned the experimental design.

Using DOE successfully depends on understanding eight fundamental concepts:

1. Set good objectives

Objective must be define before designing any experiment,. The focus of the study may be to screen out the factors that are not critical to the process, or it may be to optimize a few critical factors. A well-defined objective leads the experimenter to the correct DOE.

2. Measure responses quantitatively

Many DOE adoption fail because their responses are unable to be measured quantitatively. Responses that is not measured quantitatively will not be precise enough to be applied using DOE.

3. Replicate to dampen uncontrollable variation (noise)

The more times replication is done, the more precise we can estimate the response. Replication improves the chance of detecting a statistically significant effect (the signal) in the midst of natural process variation (the noise). In some processes, the noise drowns out the signal. Before DOE is implemented, it helps to assess the signal-to-noise ratio. Then we can determine how many runs will be required for the DOE. We first must decide how much of a signal we want to be able to detect. Then we must estimate the noise. This can be determined from control charts, process capability studies, analysis of variance (ANOVA) from prior DOEs or a best guess based on experience.

4. Randomize the run order

Run order should be randomized to avoid influence by uncontrolled variables such as tool wear, ambient temperature and changes in raw material, etc. These changes, which often are time-related, can significantly influence the response. If the run order is not randomized, the DOE may indicate factor effects that are really due to uncontrolled variables that just happened to change at the same time.

5. Block out known sources of variation

Blocking screens out noise caused by known sources of variation, such as raw material batch, shift changes or machine differences. By dividing the experimental runs into homogeneous blocks, and then arithmetically removing the difference, we can increase the sensitivity of the DOE. We should not block anything that we want to study.

6. Know which effects will be aliased

An alias[1] indicates that we have changed two or more things at the same time in the same way. Even unsophisticated experimenters know better, but aliasing is nevertheless a critical and often overlooked feature of Plackett-Burman, Taguchi designs or standard fractional factorials.

7. Do a sequential series of experiments

Designed experiments should be executed in an iterative manner so that information learned in one experiment can be applied to the next. To remain flexible, we must plan for a series of sequential experiments. A good guideline is not to invest more than 25 percent of the budget in the first DOE.

8. Always confirm critical findings

Take the time to do a confirmation run and verify the outcome. Good software packages will provide a prediction interval to compare the results within some degree of confidence. In statistics there is always uncertainty in your recommendations. Be sure to double-check your results.

Well planned and conducted experiment allows the experimenter to determine both size and the statistical significance of each of the factors and also the interactions between factors. DOE consists of several designs but only two topics on blocking designs will be covered in this thesis.

[1] When the estimate of an effect also includes the influence of one or more other effects

2.1.1 BLOCKING DESIGN

The three basic principles of experimental design are replication, randomization and blocking. (See http--www.stat.vt.edu-~oliver-stat5616-handouts-DOEPrinciples.pdf):

Randomization	i. Provides justification for methods of statistical inference. ii. To ensure validity of the estimate of experimental error
Replication	i. Each treatment must be applied independently to several experimental units ii. Provides the capacity to increase the precision for estimates of treatment means
Local control	i. Experimental Units are grouped such that the variability of units within the groups is less than that among all units prior to grouping. ii. Differences among treatments are not confused with differences among experimental units. iii. Experimental error is reduced by the variability associated with environmental differences among groups of units. iv. Effects of **nuisance** factors which contribute **systematic** variation to the differences among experimental units can be eliminated. v. Analysis is more sensitive.

Blocking is a design technique used to improve the precision with which comparisons among the factors of interest are made. Often blocking is used to reduce or eliminate the variability introduced by nuisance factors[2]. However, in this project only Randomized Complete Block Design (RCBD) and Latin Square Design are included. Next chapter will discuss in further detail about these two topics.

[2] Factors that may influence the experimental response but in which we are not interested.

2.1.2 RANDOMIZED COMPLETE BLOCK DESIGN (RCBD)

Randomized Complete Block Design (RCBD) is a classical error control design. It is represented in tabular form. In which, the rows represents the treatments and the columns represents the blocks. (*See Appendix VI and VIII on page 88 and 90 for Statistical Model and table of ANOVA*) The experimental units are divided into homogeneous groups of material (called BLOCK) each of which constitutes a single replication of the experiment. At all stages during the experiment, the techniques applied within a block should be as uniform as possible, thus keeping experimental error within blocks as small as possible. Differences between blocks are permitted to be large, but are not of major concern in the analysis, since the comparisons of treatments and the computation of experimental error is done within blocks. Blocking will be effective only if the error variance among units within blocks is smaller than the error variance over all units. The division into blocks needs to be made only at those stages during the study where failure to do so would increase experimental error. For example, blocking may not be required until data are being collected or laboratory analyses are being conducted. The key to successful blocking is to minimize the variance among units within blocks while maximizing the variance among blocks. Precision usually decreases as the number of experiment units (or size of units) per block increases. Therefore block size should be kept as small as possible.

a) Advantages of blocking:

i. Improves precision (relative to CRD)

An effective blocking reduces error variance, thus resulting in greater precision or reduces the number of replications needed to achieve equal precision. It will also create better treatment balance.

ii. Flexible

We can apply any number of treatments or any number of block replicates and even extra replications for certain treatments may be included. Furthermore, not all blocks need to contain the same number of units.

b) Disadvantages of blocking:

i. Certain assumptions may be required for some tests of hypothesis.
ii. Interactions between block and treatment may make interpretation of treatment effects more difficult.
iii. Blocking for a single factor may not be precise or will not provide sufficient error control.
iv. The gain in precision due to blocking generally decreases as the number of experimental units in a block increases.
v. Block degrees of freedom result in a reduction in error degrees of freedom, thus reducing sensitivity in small experiments or when experimental unit heterogeneity is small.
vi. Requires some prior knowledge about variability of experimental units for successful blocking.

After the experimental units have been blocked, treatments are assigned at random within each block such that each treatment occurs once in every block for the simple RCBD or as planned if more or less than once per block. During the conduct of the experiment where the order of processing the material may make a difference, units are processed by block and in a completely random order within each block.

NEED OF RCBD:

i. Where sufficient knowledge exists about the heterogeneity of the experimental units to provide for effective blocking. Such as in field experiments, in experiments where lack of uniformity information is available or even in experiments with potential position and location effects
ii. If more than one source of heterogeneity exists in the experimental material, sources may be confounded or multifactor
iii. When it is desirable to compare the treatments over a wide range of experimental material (variety trials) to increase generalizability.

In RCBD, ANOVA[3] is set up to help the experimenter to determine which factor affecting the response of the process and also to decide further significance tests. Information that has been gathered from the experiment is turn into tabular form. In which this table can help the experimenter to do observation in detail (see table 2.1). Calculation on $y_{i.}$ and $y_{.j}$ (Table 2.1) will help the experimenter to set up the ANOVA table. See Appendix VIII on page xi for detail calculation on ANOVA.

[3] Analysis of variance: A mathematical process for separating the variability of a group of observations into assignable causes and setting up various significance tests.

Table 2.1: Simplified Table to Represent Data

Treatments (Rows)	**Column (Block)**			**Total**	**Means**
	1	2	b		
1	y_{11}	.	y_{1b}	T$_1$	$\overline{y_1}$
2	.	.	.	.	.
3	.	.	.	.	.
t	y_{t1}	y_{t2}	y_{tb}	T$_t$	$\overline{y_t}$
Total	B$_1$	B$_2$	B$_b$	G	$\bar{y}$
Means	$\overline{B_1}$	$\overline{B_2}$	$\overline{B_b}$		

Using Table 2.1, we can introduce notation that is helpful in performing analysis of variance (ANOVA). The notation is s below:

y_{ij} : *obcervation for treatment i in block j*

t : *number of treatment*

b : *number of block*

n : *total number of sample measurements* : $n = bt$

T_i : *total number of observation receiving treatment i*

B_j : *total number of observation in block j*

G : *Total of all sample observation*

$\overline{y_1}$: *sample mean for treatment i*; $\overline{y_i} = \frac{T_i}{b}$

$\overline{B_j}$: *sample mean for block j*; $\overline{B_j} = \frac{B_j}{t}$

$\bar{y}$: *overall sample mean*; $\bar{y} = \frac{G}{n}$

2.1.3 LATIN SQUARE DESIGN

The term *Latin Square* was first used by Euler, 1782. Latin Square Design is used when the factors of interest have more than two levels and there are no interactions between factors. A *Latin square* of order n is an $n \times n$ array in which each of the n^2 cells contains a symbol from an alphabet of size n, such that each symbol in the alphabet occurs just once in each row and once in each column(see Table 2.1). The alphabet is completely arbitrary, but it is often convenient to take it to be the set {1, 2, , ,n}. This has the advantage that the same set indexes the rows and columns of the square. It is clear that, if we permute in any way the rows, or the columns, or the symbols, of a Latin square, the result is still a Latin square.

(See appendix for Statistical Model and table of ANOVA on page 89 and 91)

Table 2.1(a): Example Table for Latin Square Design

Rows	Columns			
	1	2	3	4
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C

As we can see in Table 2.1(a) at each coordinate, one Latin Letter will only occur once. Formulations can be derived by adding each value for each Latin Letters (see Table 2.1(a)). Refer to Appendix IX on page 91 for detail calculation on ANOVA for Latin Square Design. Existence of calculation on formulation is what differ Latin Square Design from RCBD.

Table 2.2: Formulations for Latin Square Design

Latin Letter	Treatment Total
A	Value A at Column 1 + Value A at Column 2 + Value A at Column 3 + Value A at Column 4
B	Value B at Column 1 + Value B at Column 2 + Value B at Column 3 + Value B at Column 4
C	Value C at Column 1 + Value C at Column 2 + Value C at Column 3 + Value C at Column 4
D	Value D at Column 1 + Value D at Column 2 + Value D at Column 3 + Value D at Column 4

Table 2.3: Summary on RCBD and Latin Square Design

	RCBD	Latin Square Design
Definition	An experimental design for comparing *t* treatments in *b* blocks. Treatments are randomly assigned to experimental units within a block, with each treatments appearing exactly once in every block	A *t x t* Latin Square Design contains *t* rows and *t* columns. (Homogeneous). The *t* treatments are randomly assigned to experimental units within the rows and columns so that each treatment appears in every row and in every column.
Advantages	- Useful design for comparing *t* treatment means in the presence of a single extraneous source of variability. - The statistical analysis is simple. - Design is easy to conduct. Can be used to accommodate any number of blocks.	- Particularly appropriate for comparing t treatment means in the presence of two sources of extraneous variation, each measured at t levels. - Analysis is quite simple.

Disadvantages	- Experimental units within a block must be homogeneous; the design is best suited for a relatively small number of treatments. - The design control for only one extraneous source of variability (due to blocking). - Additional extraneous source of variability tend to increase the error term, making it more difficult to detect treatment differences. - The effect of each treatment on the response must be approximately the same from block to block.	- although can be constructed for any value of t, it is best suited for comparing t, treatments when $5 \le t \le 10$. - Any additional extraneous source of variability tends to inflate the error term, making it more difficult to detect differences among the treatment means. - The effect of each treatment on the response must be approximately the same across rows and columns.

Table 2.3 has summarized on RCBD and Latin Square Design. For more information on calculating and setting up the table of ANOVA, see Appendix IX on page 91. Instead of calculating the values manually, we can also utilize any of the statistical analysis software that is commercialized in the market. There are many of them but in this thesis the software is restricted to two only. That is, SPSS and MINITAB. Detail explanation on this two software will be discussed in the next section.

2.2 STATISTICAL ANALYSIS SOFTWARES

There is a lot of statistical analysis software available in market. All of this software has the capability to assist experimenter to do analysis and to get better understanding regarding response of certain process. Result from the analysis, will enable the experimenter to decide on which significance test to be carried out. Next two chapters will clarify on two statistical analysis software and their capabilities.

2.2.1 SPSS

SPSS is a software package used for conducting statistical analyses, manipulating data, and generating tables and graphs that summarize data. Statistical analyses range from basic descriptive statistics, such as averages and frequencies, to advanced inferential statistics, such as regression models, analysis of variance, and factor analysis. SPSS also contains several tools for manipulating data, including functions for recoding data and computing new variables as well as merging and aggregating datasets. SPSS also has a number of ways to summarize and display data in the form of tables and graphs.(*See appendix XVII on page 117 to have a look at the interface of SPSS).*

2.2.2 MINITAB

MINITAB is a straightforward software package to use, since it uses the ever-present Microsoft Windows menu and windowing system. Familiarity with any Windows software will be sufficient to know how to get around in MINITAB. The difficult part is knowing where to look. MINITAB is a solid statistical software. Among the capabilities of MINITAB are: creating new variables in data transformation, random number generation, descriptive statistics, summary statistics, set up the tables for descriptive plots such as histograms, box plots, scatter plots, it can deal with correlation & regression such as correlation, simple linear regression, MINITAB can also help experimenter to determine the hypothesis testing such as one sample tests, two sample tests and lastly we can use MINITAB to set up the ANOVA.(*see Appendix XVI to experience the MINITAB interface*)

2.3 MAPPING TECHNIQUES

The term ``mind map'' and ``concept map'' are used interchangeably. However there are differences (see Table 2.3.1) between these two terms. Moreover, the primary role of the concept map is an educational tool used to:

i. explore prior knowledge and misconceptions,
ii. encourage meaningful learning to improve students' achievement,
iii. measure concept understanding

Mind and Concept map are two mapping techniques that are clarified in this chapter. There are so many sources that are found discussing about these two techniques. Mapping techniques is believed to help in web designing because it simplifies the displaying of basic parts. In which, it may consist of one main idea or various sub ideas and can be represented as tree diagram to help the viewer understand a certain topic with the right flow. Mapping techniques is perfect for non integration parts. It will also beneficial for quick reviewing. In which, it engages more to the brain process, functions as an effective mnemonics because it may contain abbreviations or short terms and also its contents are easy to be remembered. Applying mapping techniques will also avoid the web designer from designing a 100% textual content of the website. Where, certain points are converted into graphical (mapping) approach to deliver its concept. Mapping technique will consolidate information from variety sources, summarize all the gathered information and deliver it using mapping techniques approach. This is because, mapping techniques will help a big deal in presenting the overall structure of the information gathered.

2.3.1 MIND MAPPING TECHNIQUE

Mind Mapping is one of the popular mapping techniques. The technique is invented and copyrighted by *Tony Buzan*. He describes mind maps as: "*a mind map consists of a central word or concept, around the central word you draw the 5 to 10 main ideas that relate to that word. You then take each of those child words and again draw the 5 to 10 main ideas that relate to each of those words.*" The mind map approach will assist its user in defining the detail explanations on one main concept. There several type of mind map but the most commercial is the tree diagram. Regardless of any diagram that is used, the concept is the same. Mind map should only emphasize on one main idea (concept) and sub-ideas are reflected to the main idea for the purpose of explaining the main idea. (*See appendix IV on page 82 to see examples diagrams on mind mapping*)

The Advantages of Mind Mapping:

1. Mind maps work the way the brain works
2. Mind maps allow associations and links to be recorded and reinforced
3. Mind maps use just keywords and key images
4. The organization of a mind map reflects the way your own brains organizes ideas
5. Mind maps allow the user to work out in all directions

2.3.2 CONCEPT MAPPING TECHNIQUE

Concept Map is a technique that converts all information into nodes of concepts. All these nodes are interconnected with links whether it is an edges or arcs or straight lines. As a representation of knowledge, all nodes represent concept and links represent relations between concepts. These links can be non-directional or uni-directional or bi-directional.

Prof. Joseph D. Novak is the one that responsible for developing the concept mapping approach. His idea is based on theories of David Ausubel[4], who stressed the

[4] His theory applies only to reception (expository) learning in school settings. He states that there are differences between reception learning and rote and discovery learning.

importance of prior knowledge in being able to learn about new concepts. Novak concluded that *"Meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures".* According to *Novack*, “the problem with much of reception learning in schools is that students learn to memorize definitions of concepts or algorithms to solve problems, but fail to acquire the meanings of the concepts in the definitions or formulas”. Thus, creating a concept map of a particular domain makes learning an active process rather than a passive one.

NEED OF CONCEPT MAP

1.1. To generate ideas. In which, brainstorming is well performed if the ideas is arrange as distribution of related concepts.
1.2. To design a complex structure. Long Text, hypermedia and large website is critical if it does not apply concept maps. Concept maps make the presentation of these things more systematic and easy to read.
1.3. To communicate complex ideas. Rather that writing the whole explanations into long paragraph, concept mapping approach will impact on better understanding.
1.4. To aid learning by explicitly integrating new and old knowledge.
1.5. To assess understanding or diagnose misunderstanding.

The difference between concept maps and mind maps is that a mind map has only one main concept, while a concept map may have several. This comes down to the point that a mind map can be represented as a tree, while a concept map may need a network representation. But above all, both techniques will help its user in a great deal. It will make learning easier, it will also make the reading source more interesting, it will as well elaborate certain topic in detail but short and reduce time consuming when studying on the topic because it is faster to read points that a whole paragraph.

Table 2.3.2: Things that You Should and should not do
In Performing Mapping Techniques

Do’s	Don’ts
b) More pictures, less words (use key words) b) Put key words on lines c) Never limit your ideas d) Do not get stuck in one area e) Be creative. Creativity aids memory f) Use hierarchy and numerical order g) Think three dimensionally h) Keep your printing as upright as possible i) Variation of size of printing, line and image j) Make the central line thicker k) Never be stingy on spaces	a) Concentrate at one area b) Concentrate on graphics only c) Highlight sub ideas over the main ideas d) Judge or hold back e) Start a new sheet when run out of space f) Concentrate at one area

Table 2.3.1 Differences between Mind Map and Concept Map

Mind Map	Concept Map
a) One main idea b) Start from center c) Note taking technique	a) several main idea (2 or more concept are linked) b) start from the top c) there are 4 major categories of concept maps (Hierarchical, spider…)