Asian Journal of Education and Social Studies

5(4): 1-7, 2019; Article no.AJESS.52863
ISSN: 2581-6268

The Effect of 'Why' Statement on Decreasing the Resistance in Engineering Education

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Authors' contributions

This work was carried out in collaboration among all authors. Author KD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AA and AB managed the results of the study. Authors MNA, LA and AA managed the editing. Authors managed the analysis of results. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJESS/2019/v5i430162
Editor(s):
(1) Dr. Velan Kunjuraman, Lecturer, Faculty of Hospitality, Tourism and Wellness, Universiti Malaysia Kelantan (UMK), Malaysia.
Reviewers:
(1) Mohammad Hasan, Aligarh Muslim University Centre Malappuram, Kerala.
(2) Marcelo Simões Mendes, University of Sorocaba, Brazil.
(3) David Lizcano, Madrid Open University, UDIMA, Spain.
Complete Peer review History: http://www.sdiarticle4.com/review-history/52863

Original Research Article

Received 23 September 2019
Accepted 27 November 2019
Published 30 December 2019

ABSTRACT

The presented paper investigated focusing on 'why' statement in engineering education. For studying the effect of utilizing 'why' statement in teaching comparing with other statements such as 'what', 'how' and determination (state), five aspects were investigated to spot the light on the influence of the 'why' statement in teaching over several angles. So, passing, captivating the attention, review the taught idea, motivation and concluding the taught idea were used for testing the hypothesis. Five questionnaires were used for these aspects. Two manners of the statements' order in the questionnaires were used. The first manner, the 'why' statement is always the first, but in the second manner can have any order. The results showed the high effect of 'why' and 'what' statements in persuasion the students studying the engineering subjects. The second manner had a better effect on enhancing the results of 'why' statement.

Keywords: Engineering education; motivation; students relationship; students learning.

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1. INTRODUCTION

During the Second World War, the need for convincing and influencing people around the world became important. For this reason, some researchers began to study the influence of propaganda on people to control the outcome of certain events [1]. The University of Wale was the first school that studied the propaganda effect on people persuasion. This was the first step for building the science of persuasion psychology. After that many researchers have contributed to this science such as Robert Cialdini [2-9] who gave one of the most significant books titled the science of persuasion which has strong effects on focusing awareness on the parameters or frequencies that makes persuasion in social life, marketing and sales, and education that made that interesting and scientific.

In education, particularly engineering education, there are many complications behind explaining the tough and difficult engineering concepts. The objective is to find if there are ways to convince the students to acquire more knowledge easily with less resistance and faster adoption. Therefore, we need to build a new educational technique to make the process absorbed in an easier way and decreases the student resistance against the information being given to them [10-13].

In this research study, we intend to investigate the effect of emphasizing on introducing the concept explanations based on why tool more than what and how. The motivation behind that is to affect the unconscious mind mode to be more present in the knowledge absorption. This will be studied by several questionnaires that are built to analyze certain meaningful frequencies.

2. METHODS

To investigate the effect of why statement for attracting the awareness of the students and then their consciousness towards the concept of a tough technical phenomena five questionnaires are designed [14]. Each questionnaire will study the effect of why a statement from a different perspective. This will allow us to see the object from different angles and thus we will be able to get more meaningful and profound results.

Aspect1, For pacing the students, we need to find a way to build a rapport, therefore we will be synchronized on the same frequency with our students. Rapport is an excellent way to make a sort of credibility and then trust will be built to make the understanding and learning an easy process. This will be conducted by asking a question to excite students by examining their relationship to the importance of the subject and how they see it in their own eyes. The questionnaire is prepared as in Table 1 where we investigate four statements types ‘how’, ‘what’, and ‘determination’ statements along with ‘why’ statement. Two manners are adopted; the first 'why' is the first, the second the 'why' in a different order.

In Fig. 1, we can notice the results of aspect1 at the first column of the two Figures (from the left). For the first manner, the ‘why’ statement has 46 out of 181. It means the second after ‘what’ statement with 53. The 'how the statement has 33 and the lowest has state case with 26. But in a second manner, 'why' is the best with 70 out of 194, ‘what’ has 52, the state case has 36, and ‘how’ case has 36. We can notice that the second manner has a better effect on enhancing the results of 'why'.

Aspect 2, Captivating the attention (hook): to captivate the attention, we need to find out different strategies for attracting the student to make them present most of the time. One of the most effective strategies is questioning the student at the right time, specially before starting a new concept. The “why” statement could be very effective based on the curiosity that is contained in the answer.

Table 1. The questionnaire of student's relationship to the taught subject

Type		Statement	Check (√)
1.	Why statement	Why we need to know about circuit analysis?	
2.	How statement	How we could know that circuit analysis is important?	
3.	What statement	What is the importance of circuit analysis?	
4.	Determination statement (state)	Determine the importance level of the circuit analysis subject?	

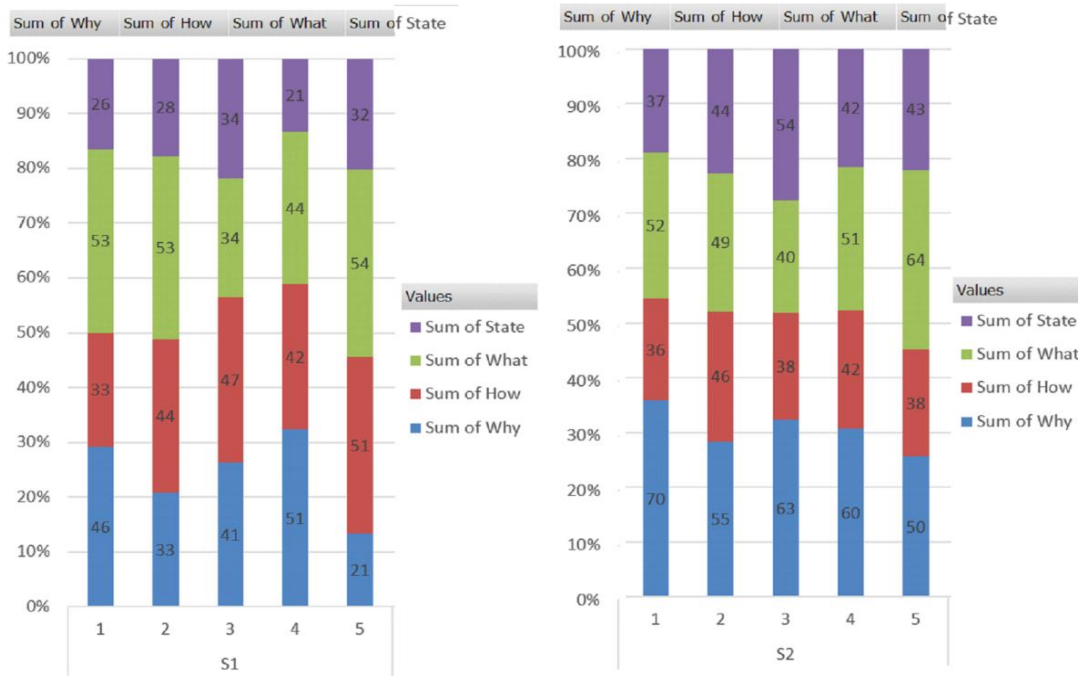

Fig. 1. The results of our investigation of the five aspects of the two manners. The left figure illustrates manner of 'why' is the first, the right figure illustrates the manner of 'why' in a different order

Table 2. The questionnaire of captivating the student to the taught subject

Type	Statement	Check (√)
1. Why statement	The reason behind using Ohm's law in such a wide range is because it is a perfect mathematical model that solves the current- voltage characteristics about resistance.	
2. How statement	By using Ohm's law, we are able to solve most circuit analysis problems.	
3. What statement	Ohm's law is a mathematical formula that describes a current, voltage, and resistance relationship in a simple way.	
4. Determination statement	Ohm's law is one of the most important mathematical tools in circuit analysis.	

In Fig. 1, we can notice the results of aspect2 in the second column of the two figures (from the left). For the first manner, the 'why' statement has 33 out of 181. It means the second after 'what' statement with 55. The 'how statement has 45 and the lowest has state case with 28. But in a second manner, 'why' is the best with 55 out of 194, 'what' has 49, the 'how' case has 46, and state case has 44. We can notice that the second manner has a better effect on enhancing the results of 'why' again.

Aspect 3, Review and questioning tool: After explaining some ideas in the engineering subjects, we review the idea by using some questions such as recalling questions, embedded question, open-ended questions, and tag questions. The review stage is maintaining remembering and enhancing the understanding of the engineering ideas. Therefore, this will enhance the learning of such sophisticated engineering domain.

In Fig. 1, we can notice the results of aspect3 at the third column of the two figures (from the left). For the first manner, the 'why' statement has 41 out of 181. It means the second after 'how' statement with 47. The 'what' statement has 34 and the same for state case with 34. But in the second manner, 'why' is the best with 63 out of 194, state has 54, 'what' case has 40, and 'how' case has 38. We can notice that the second

manner has better effect on enhancing the results of 'why'.

Aspect4, Motivation: the sophistication of the engineering subject could lead to a kind of barrier, discouragement, lack of motivation and lack of excitement. Therefore, it is wise to find out a linguistic structure that leads to more motivation and enthusiasm. The use of why statement could trigger more deep thinking and could eventually deliver more curiosity for knowledge.

In Fig. 1, we can notice the results of aspect4 at the fourth column of the two figures (from the left). For the first manner, the 'why' statement has 51 out of 181. It means the best one, the 'what' statement with 44. The 'how' statement has 42 and the state case is the last with 21. In the second manner, 'why' is the best with 60 out of 194, 'what' case has 51, state and how are the same with 42. We can notice that the second manner has better effect on enhancing the results of 'why'.

Aspect 5, for concluding the idea of the lecture: this point tests the possibility of using "why statement" for concluding and summarizing the presented idea. To briefly focus, there are many ways of idea presenting in a short linguistic structure that could guarantee a better finalizing and closing the explained idea during the lecture. In the following questionnaire, we test the "why statement" besides other statement for better concluding the presented idea.

In Fig. 1, we can notice the results of aspect5 at the fifth column of the two figures (from the left). For the first manner, the 'why' statement has 21 out of 181. It means the last one, the 'what' statement is the best with 54. The 'how' statement has 41 and the state case is the last with 32. In the second manner, 'why' is the second with 50 out of 194, 'what' case is the best that has 64, the state case has 43, and 'how' has 43. We can notice that the second manner has better effect on enhancing the results of 'why'.

Table 6 contains the total number of students and teachers participated in the study, for all aspects and manners. The results for teachers of the five aspects and the two manners as a total are as follows: the 'why' statement has 61. It means the first one together with 'what', which has also 61, the state Has 53, and the 'how' statement is the last that has 41.

Table 3. The questionnaire of review the taught subject

Type	Statement	Check (√)
1. Why statement	Why for maximum power, the load impedance must equal the Thevenin impedance.	
2. How statement	How do we calculate the load impedance to consume maximum power	
3. What statement	What is the value of load impedance to consume maximum power	
4. Determination statement	Determine the load impedance to achieve Maximum power consumption	

Table 4. The questionnaire of motivating the students to the taught subject

Type	Statement	Check (√)
1. Why statement	Do you know why a solid knowledge of electronics is the key to most upcoming innovations in the immediate future	
2. How statement	Do you know how we can lead to more innovation by studying circuit analysis?	
3. What statement	Do you know what is the most important properties that makes the circuit analysis a basic subject for the electrical engineering?	
4. Determination statement	Do you know the qualities that make the circuit analysis a basic subject for the electrical engineering?	

Table 5. The questionnaire of concluding the taught subject

Type	Statement	Check (√)
1. Why statement	At the end of our lecture, we can conclude why we need Ohm's law for circuit analysis. The reason is the possibility and convenience characteristics contained in Ohm's law.	
2. How statement	At the end of our lecture, we can conclude how we use Ohm's law for circuit analysis by its convenient characteristics that helped us solve different questions.	
3. What statement	At the end of our lecture, we can conclude what we must know about the characteristics of Ohm's law, to successfully use it in a proper way to solve circuit analysis problems.	
4. Determination statement	At the end of our lecture, we can determine the importance of Ohm's law for circuit analysis by mentioning its characteristics and explain the concept behind that	

Table 6. The total number students and teachers and their results of all aspects

Row Labels	Sum of Why	Sum of How	Sum of What	Sum of State
S	**490**	**417**	**494**	**361**
1	116	69	105	63
2	88	90	102	72
3	104	85	74	88
4	111	84	95	63
5	71	89	118	75
T	**61**	**41**	**61**	**53**
1	18	9	13	3
2	5	11	15	12
3	17	3	8	15
4	16	10	13	4
5	5	8	12	19
Grand Total	**551**	**458**	**555**	**414**

Table 7. An example lecture preparing based on 'why' statement of circuit analysis subject

Chapter 1	Circuit analysis	Driving question type 'why'	Answer
Lecture 1	Fundamental electric quantities	1. Why the direction of current from positive terminal to negative?	Because …
		2. Why is the voltage proportional to current?	Because …
		3. Why is the resistance proportional to the length and inversely proportional to the cross section area of the material?	Because …
Lecture 2	Basic relationships	1. Why resistances connected in parallel are not added algebraically?	Because …
		2. Why is the sum of voltages in a close loop is equal to zero?	Because …
		3. Why is the resistance in each branch of a balanced delta network equal to 1/3 the resistance in a Y network?	Because …
.	.	.	.
.	.	.	.
.	.	.	.

Chapter 1	Circuit analysis	Driving question type 'why'	Answer
Chapter 2	…	…	…
Lecture 1	…	…	…
Lecture 2	…	…	…
.	.	.	.
.	.	.	.
.	.	.	.

Lecture building based on "why" [1]: Before starting the planning of an engineering course lectures, it is wise to prepare the content of the lectures based on "why". The reason behind that is to be prepared to build the thinking of the scientific content based on finding reasons, motivations, origins, and justifications that "why" thinking is responsible for. In the Table 7, an example of circuit analysis subject is shown.

3. CONCLUSION

The presented study investigated the using of 'why' statement in the engineering education. For studying the effect of utilizing 'why' statement in enhancing the engineering education comparing to other statements such as 'what', 'how', and state, five aspects have been investigated to test the influence of the 'why' statement on the teaching over several angles. In this paper, we have investigated the use of 'why' statement in passing, captivating the attention, review the taught idea, motivation, and concluding the taught idea. Five questionnaires were used for these aspects with two manners of the statements' order in the questionnaires. It has been shown that the 'why' and 'what' statements have excellent effect in persuasion the students for better learning of the engineering subjects. Based on the choice of students and teachers, the two statements have been competing in enhancing the learning. The second manner had a better effect on enhancing the results of 'why'.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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DOI: 10.4135/9780857028051.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/52863