Effect of Concept-Mapping by using Frayer Model on Academic Achievement of Prospective Teachers

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Abstract

Frayer Model is the method of assessment used for concept making but there is still a debate in literature that how effectively Frayer Model helps in improving concept building. The main purpose of this research was to contribute in literature through investigating the effect of Frayer Model on academic achievement of prospective teachers. This study employed quasi-experimental design and sample were 87 prospective teachers. Before experiment, pretest of both groups was taken to ensure that they are at same level. After pretest, treatment was applied in different timeframes for the period of sixteen-weeks and then posttest was taken. Pretest and posttest were same that were developed by applying basic rules and guidelines of test development. The validity of the test was ensured by five experts in the field of assessment and curriculum whereas, psychometric analysis was used to measure the reliability and item characteristic of the test by piloting it on 200 prospective teachers. The data were also collected by using Frayer Model sheets to develop the concepts of prospective teachers on different areas of content taught i.e. foundations, models, designs, types etc. Dependent sample t-test was applied to explore the effect of Frayer Model on academic achievement of prospective teachers while independent sample t-test was applied to compare the scores of two groups. On the basis of research findings, it was concluded that Frayer Model has improved the concepts as well as academic achievement and understanding of prospective teachers. Further, it was recommended to use Frayer model in the classrooms to improve the students' academic achievement and develop concepts.

Keywords**:** *Academic Achievement, Assessment, Frayer Model, Prospective Teacher*

1. Introduction

The field of "Assessment" encompasses the set of methods, processes and techniques for designing, collecting, scoring, analysing, and interpreting the

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evidences about students' learning. These methods are eventually supportive in making decisions during teaching (material needs to be taught again or differently), learning (material a student need to revise?), administration (students ready for promotion to the next grade), policymaking (areas of the curriculum need teacher development), and accountability (students be given the supreme scholarship prize). The process depends on expert judgment and statistical analysis of the quality of the assessment methods, their relationship to intended objective or outcomes, and the validity of consequences (Brown, 2018).

Assessment is important at all levels as it is an essential tool for improving understanding of the students when it is considered against realistic standards and thoughtful expectations (Stake, Contreras, & ArbesúIt, 2018). It is both qualitative and quantitative in nature and requires strong, theoretically well-grounded knowledge of learning materials and sequences (curriculum), instructional actions (teaching), and what it means for students to 'know' something (learning). In our educational structure, assessment is basically an ongoing process to assemble, evaluate and reflect on the facts that are involved in improving students' learning. It always provides value judgment based on the results desirability (Brookhart & Nitko, 2015).

Good assessment begins with a curriculum, which clearly mentions the expectation of learning, understanding and making sure the progress of students (Furco & Moely, 2012). It has its roots strongly embedded in the curriculum. Good assessment leads to better learning of the students and it started from the way an instructor instructs them. Before delivering instruction, it is very important to check the prior knowledge of the students to pick a point where to start. There are many ways an instructor can use to check the prior knowledge of the students and on the basis of their knowledge the concept mapping of the students begins.

In this research, Frayer Model is used as an assessment method to check the prior understanding of the prospective teachers for further concept making in the course of Curriculum Development. Frayer model is actually the representation of a concept or idea in picture or graph form that creates the ease for students to grasp the concept. Frayer model is basically a grid that is divided into four sections to explain something to the learners; it also helped the teachers to convey their lesson effectively with full command. Keeley (2013) stated that Frayer Model activates thinking of the students about a topic or concept and is also helpful in assessing their conceptual understanding. Frayer Model supports a teaching learning situation with a number of domains like ranking performances of students; classify the work into different categories, evaluating concepts etc. Buehl (2014) also mentioned in his study hat Frayer Model is used

at the beginning of the instruction to check the prior understanding of students about the concept being discussed. It may also be used to find out the students' misconceptions.

1.1 Rationale of the Study

This study was conducted to fill the research gap as at university level no significant research was found by the researcher to find the effect of concept mapping on students' academic achievement. Although many researches (Khoshsima & Saed, 2015; Liu, 2016; Panjaitan & Sihotang, 2020; Urquhart & Frazee, 2012; Talah, 2015) at college or school level used concept mapping to improve students' academic achievement. Teaching strategies/methodologies act as a bridge between instructors' teaching and students' academic achievement. It minimizes the learning gap and improves the quality of teaching-learning process by increasing the learning proficiency of students. In Pakistani education system, traditional teaching is used that just deal with the limited performance of the students instead of guiding them in the process of learning. They have more focus on the capacity of students rather than on their abilities to think systematically, comprehend and analyze the things. In view of this approach, this study was designed to determine the effect of concept mapping by using Frayer Model on students' achievement. This method may enhance students' learning at undergraduate level and make them able to think more critically.

1.2 Objectives of the Study

The objectives of the study were

1. Find out the effectiveness of Frayer Model as an assessment tool in concept making of prospective teachers.
2. Find out the increase in academic achievement of students taught through Frayer Model as an assessment tool in classroom.
3. Explore that how different levels (definitions, facts, examples, non-examples) of Frayer Model are useful in concept making and improving academic achievement.

1.3 Significance of the Study

Teachers and teacher educators are looking for research that may improve students' achievement scores in the domain of teaching and learning. The research on Frayer Model as an assessment tool done primarily on prospective teachers has filled possible gap in the research and assessment. It has further confirmed the recent emerging construct in the field of assessment by confirming that assessment method (Frayer Model) is helpful in developing concepts. This study can help the school education stakeholders to understand the ways to improve the academic achievement through promoting new methods of assessment.

This study may be beneficial for teachers and teacher educators in a way to improve the performance of prospective teachers by using assessment in the classroom. Other level teachers may also get benefit from this study to improve the performance of their students. Curriculum developers may get an idea from this study while designing or planning curriculum component i.e. assessment in manuals or courses. The policy makers may use the results of this study to design and include innovative assessment methods instead of using traditional methods of assessment. Students at different levels may also get benefit from this study in a way to use Frayer Model independently or with help of someone to develop concepts about certain topic as well as to increase their academic performance in the classroom.

2. Literature Review

There have been conducted many studies on concept mapping and the effectiveness of Frayer Model as an assessment tool on the academic achievement of students. Concept maps may be defined as a type of diagram (Umoquit, Tso, Varga-Atkins, O'Brien, & Wheeldon, 2013) or mind map (Wheeldon, 2011); however, concept maps are further delineated depending on authors' theoretical and methodological orientations (Conceição, Samuel, & Biniecki, 2017). In this study, Frayer Model is used for the purpose of concept mapping among prospective teachers. Concept mapping may act as a scaffolding that can be used at different stages of learning process and at different level for developing conceptual understanding for better learning or getting the concept (Villalon & Calvo, 2011). Chiou (2008) conducted an experimental study to determine that either concept mapping can be used to improve academic achievement of students. They conducted research on 124 participants and observe that concept making helps the students to improve their achievement significantly as compared to the traditional teaching method. The students were satisfied with the learning strategy of concept mapping, which could be helpful in improving the skills. This research focused on improving students' achievement by proposing a change of method 'concept mapping' by using Frayer Model.

Earlier in 1974-1975 a research study was conducted by Peters to find out the effect of Frayer Model as assessment method on achievement of students. This study was conducted by dividing the students randomly into two groups i.e., good and poor readers and assigned them to read the content by Frayer Model and traditional method respectively. Results of the study indicated that there was a significant difference in the performance of good and poor readers who used the Frayer Model as compared to the students who were taught in traditional ways. According to Heritage (2010), assessment methods play an integral role in achievement of learning goals which helps the students to improve their learning.

Johnson and Johnson (2008) explored that the use of higher-order goals cannot be met by just using traditional approach some assessment methods may be implied that are compatible with the level of the students, even when academic achievement of students in external tests is measured in narrow terms. Pinger, Rakoczy, Besser and Klieme (2018) investigated that instructional quality and the assessment are linked by conducting quasi experimental research. It was concluded that the assessment methods contribute in improving the performance of the students in the classrooms that are characterized by use of instructional time and lower degrees of process orientation.

Students do not come as "Blank Slates" in university. Although, they build new concepts based on their old experiences (Bransford, Brown & Cocking, 2000). Students jumped into the permanent pool of new interactions based on their knowledge and teachers must activate the prior knowledge as the first and important step of students in effective learning environment (Ambrose et al. 2010). The effective methods to activate students' previous knowledge are through formative assessments; Frayer Model is one of the effective tools of it (Keeley, 2013). It was introduced by Dorothy Frayer and her colleagues in 1969 to support concept mastery at University of Wisconsen (Frayer et al. 1969). This method is frequently used in the research studies for vocabulary development although it can be used in various contexts too because it helps the students to understand different concepts and their relationship with representative words (Bowe, 2020).

Frayer model is basically the pictorial representation of an idea or concept that is helpful for the students to understand the nature of concept. It is basically a grid design that is split into four portions i.e. definitions, facts, examples and non-examples. In left (top) corner, definition that student understands about the particular concept is written, the facts about that concept or ideas in right (top) corner, examples related to the concept in left (bottom) corner and non-examples lies in right (bottom) corner of box (Roe & Smith, 2012). The material to be written in the boxes should be developed by the students instead of coping it from the book. Studies showed that thinking and structural processes are developed in students when they are assessed through Frayer Model. It leads further in improving their learning and concepts. Moreover, it gives them the opportunity to develop their higher order cognitive skills by developing an insight about the concept (Estacio & Martinez, 2017). Febriyanto (2010) conducted a research on Frayer model and explored that this pictorial representation of idea is helpful for students to think critically and build their concepts based on their previous knowledge about the topic.

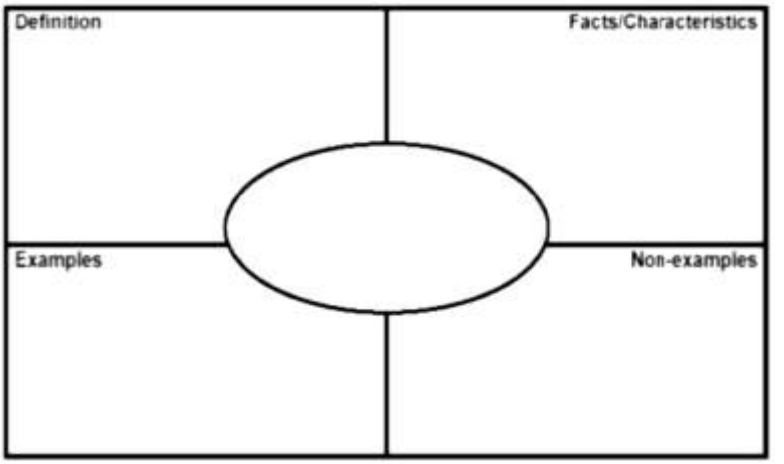

Figure 1. Frayer Model

Figure 1 shows the layout of Frayer Model that can be used in building concept knowledge of the prospective teachers. The Frayer Model layout can be adopted easily to build the concepts of the students. It can be used in the form of pictures, drawings and maps etc. (Urquhart & Frazee, 2012). It is the main purpose of this model to provide opportunity to students to understand both familiar and non-familiar concepts (Buehl, 2003; Frayer, Fredrick & Klausmeier, 1969). Keelay (2013) described in his article that Frayer model may be used individually or in small groups of 3-4 for collaborative learning. It develops the understanding about the concepts by crossing several phases like elicitation (probing to activate students), exploration and discover (students share their ideas in a group or individually before proceeding to the next), concept development (to carry the concept relevant to the knowledge student had) and reflection (how to change students thinking by considering their answers about a topic). Furthermore, Macceca (2007) described that Frayer Model is good strategy that is helpful for students to understand the concepts in better way and also distinguish that concept from others through pictorial representation. Allen (2007) added that Frayer Model is helpful in activating the thinking of students and acts as an assessment tool to measure their previous knowledge by using graphic layout. It requires the students to put all the necessary information about a particular concept on paper in the form of model. It activates the synthesizing and analyzing ability among students by allowing them to classify between examples and non-examples of the given topic. Nahampun and Sibarani (2014) further described that Frayer Model is an effective approach to develop

conceptual understanding of the students by giving them opportunity to think in different ways and perspectives. It allows the students to categorize their knowledge and demonstrate it in pictures with examples and non-examples.

The implementation of Frayer model in classroom can be carried out by in different ways. Frayer Model was implemented in the classroom by following the steps suggested by Sullivan (2014).

1. Create a Frayer Model and show it to the class to clarify the usage of this method. Give them examples as well as non-examples to make them clear about the type of answers required by modeling a concept. For this, charts may be used.
2. Keeping in view the level of understanding of students, review ideas and list of concepts.
3. In order to make students understand the concept clearly, involve them in structuring Frayer Model on paper or board.
4. Now, in order to check their understanding, ask them to build model by themselves either individually or in a group.
5. Allow students to share their charts with whole class. To represent the model, students can add graphs/pictures/charts etc. of any category.

Frayer Model is helpful for students to improve their concepts in a way to see the picture from both sides i.e. knowledge of familiar and non-familiar things about a concept. It also provides concept mapping opportunity to the students by arranging ideas about a core concept and linked it with the key words (Bauman, 2018). It is also an excellent tool for concept mapping to develop cognitive skills among students based on the structure, knowledge representation, joining of ideas, building logical connection, and allowing them to define the particular topic in their own words (Khoshsima, Saed & Yazdani, 2015). Therefore, the main purpose of this study was also to introduce the concept of Frayer Model among prospective teachers and activates their thinking about different concepts.

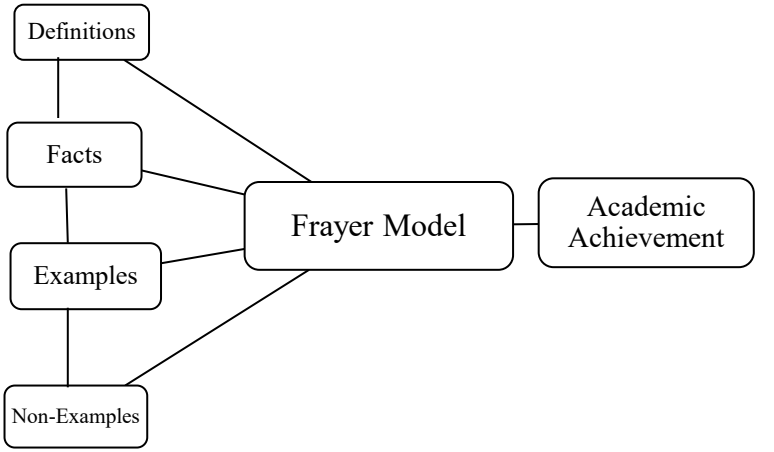

Figure 2. Conceptual Framework

3. Research Methodology

3.1 Research Design

This study was conducted under positivist research paradigm and the study was experimental in nature. The research design used for this study was quasi experimental non-equivalent control group design. This section further discussed the participants, instrumentation, procedures of experiment, data collection and results.

3.2 Sample

The sample selected for this study was prospective teachers who were enrolled parallel into two classes. Total 87 prospective teachers were enrolled and they all were taken for the study. Already existed groups were used because administration did not allow selecting them randomly due to some ethical issues. From these 87 prospective teachers, 36 were in experimental group and 51 were in control group.

3.3 Instrumentation

Lesson plans, worksheets and achievement test were used as research instruments in conducting this research. The instruments were developed by keeping in mind the student learning outcomes and methods of assessment in the course of curriculum development. The lesson plans were formulated by considering the learning objectives on four domains: knowledge, reasoning, process and product. A brief description of each of these in given in the figure 3.

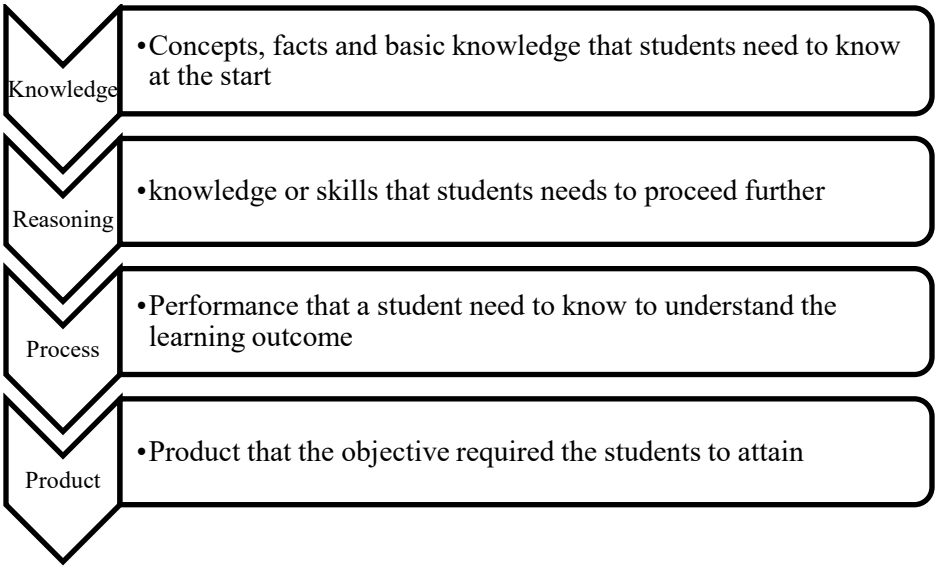

Figure 3. Domains of Lesson Plans

The achievement test (pre-test and post-test) was formed by considering "Bloom's Taxonomy of Educational Objectives". For this, a two-way specification table was formed. The final test was consisted of 30 MCQs, one essay type question and 2 short questions.

The instruments of the study as well as the assessment integration in subject were validated by five experts from education and curriculum areas and later on finalized by considering the suggestions they pose. Two hundred (200) prospective teachers were selected for piloting to check the reliability of the achievement test and items were revised after doing the item analysis of the collected data. The reliability of the final test was 0.86 and the items were selected by considering the item difficulty and discrimination range given by Ebel & Frisbie (1991) in table below:

Table 1

Characteristics of selected items

Item Characteristics	Value Range
Discrimination Range	0.2 - 0.6
Difficulty index	0.2 - 0.8
Point Bi-serial	less than 0.8

The test-items that lie under the above range were selected in the final achievement test. The final test after piloting was administered to the prospective teachers before conducting the experiment. After pre-test, treatment was applied

for the period of sixteen weeks and then post-test of these prospective teachers were taken.

3.4 Intervention Procedure

The intervention was carried out for 16 weeks to the participants who were divided already (pre-existed) into experimental group and control group. The experimental group students were assessed through using Frayer Model while the students of control group were assessed through using traditional method of assessment on regular basis. Both the groups were assessed side by side. Beside this, groups were pre-tested before the experiment to check their baseline performance. The difference in the mean scores of both groups were 0.59. According to Hanel, Maio, and Manstead (2019), that is not a big difference among participants in social sciences. After pre-test, both groups were randomly assigned to treatment groups by using simple random sampling method. Both (experimental and control) groups were taught by same method and same person, although the way of assessment was different of both the groups.

4. Data Analysis and Interpretation

The collected data were analyzed by using parametric statistics e.g. dependent sample t test, independent sample t-test and graphical representation. Dependent sample t-test was applied to find out the difference in the pretest and posttest scores of the experimental group. Independent sample t-test was applied to find out the difference in control and experimental groups. The graphs were also used in this study to represent the data from the various aspects. The analyzed data as under:

Table 2

Independent Sample t-test on Pretest and Posttest Scores of Control and Experimental Group

Test	Groups	N	Mean	SD	df	t-value	Sig. (2-tailed)
Pretest	Control	51	6.12	2.215	85	1.191	0.237
	Experimental	36	5.53	2.360			
Posttest	Control	51	14.25	2.869	85	16.82	.000
	Experimental	36	23.97	2.311			

The table 2 describes the difference in pre and post achievement scores of control and experimental group. Independent sample t-test was applied (Control M = 6.12, SD= 2.215; Experimental M = 5.53, SD= 2.360) at 0.05 level of significance, in order to compare the mean achievement scores of the prospective teachers in pretest. The t value was 1.191 with df (85) which is lower than the table value of t (1.290). In the same way, the p-value is 0.237 that is

higher than 0.05 which reflected that the prospective teachers in both groups are not significantly different from one another.

Likewise, the achievement scores of prospective teachers in posttest were (Control M= 14.25, SD= 2.869; Experimental M = 23.97, SD= 2.311) at 0.05 level of significance. The t value was 16.82 with df (85) which is higher than the table value of t (1.290) and the p-value is 0.000 that is less than 0.05 which reflected that prospective teachers in experimental group scored better in posttest when they were assessed by Frayer Model than the prospective teachers of control group.

Table 3

Dependent Sample t-test on Pretest and Posttest scores of Experimental Group

Scores	N	Mean	SD	Df	t-value	Sig. (2-tailed)
Pre-Test	36	5.53	2.360	35	35.565	.000
Post-Test	36	23.97	2.311			

The table 3 clarifies the pretest and posttest scores of prospective teachers from the treatment group. For comparing the mean achievement scores of the prospective teachers in pretest and posttest, dependent sample t-test was applied (Pretest Mean= 5.53, SD= 2.360; Posttest Mean= 23.97, SD= 2.311). The t value was 35.565 with df (85) that is higher than the table value of t (1.290). In the same way, the p-value is 0.000, which is less than 0.05 which reflected that experimental group prospective teachers scored better after intervention.

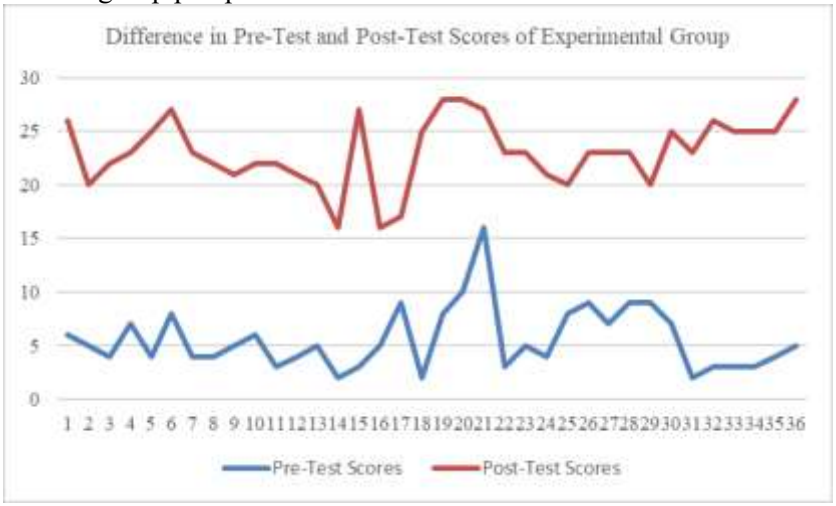

Figure 4. Graphical representation of Pre-test & Post-test scores of Experimental Group

The figure 4 shows the difference in pretest and posttest scores of prospective teachers from the treatment group. It can be clearly seen in the graph that line of pretest score of experimental group is quite below than the posttest scores of the group which shows the improvement in group during sixteen weeks of experiment.

Table 4

Independent Sample t-test of Control and Experimental Group after using Frayer Model

Groups	N	Mean	*SD*	*Df*	*t-value*	*Sig. (2-tailed)*
Control	51	2.550	.987	85	14.759	.000
Experimental	36	5.346	.666			

Table 4 shows the difference in achievement scores of control and experimental group after applying Frayer Model of assessment in each class. The values were observed on daily basis and then at the end of experiment the analysis was performed on the mean scores. Independent sample t-test was applied (Control M= 2.550, SD= .987; Experimental M= 5.346, SD= .666) at 0.05 level of significance in order to compare the mean achievement scores of the prospective teachers in both groups. The value of t was 14.759 with df 85 which is greater than the table value of t i.e. 1.290. In the same way, the p-value is 0.000 that is less than 0.05 which reflected that experimental group prospective teachers scored better when they were assessed by Frayer Model than control group.

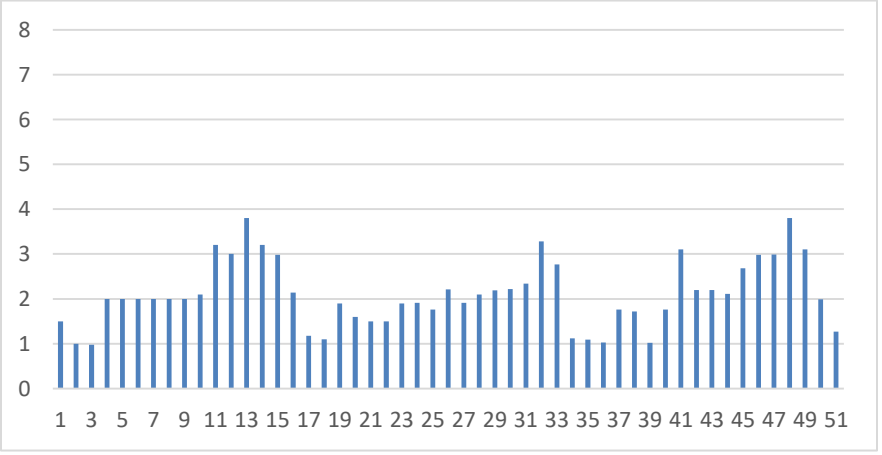

Figure 5. Graphical representation of posttest scores of control group

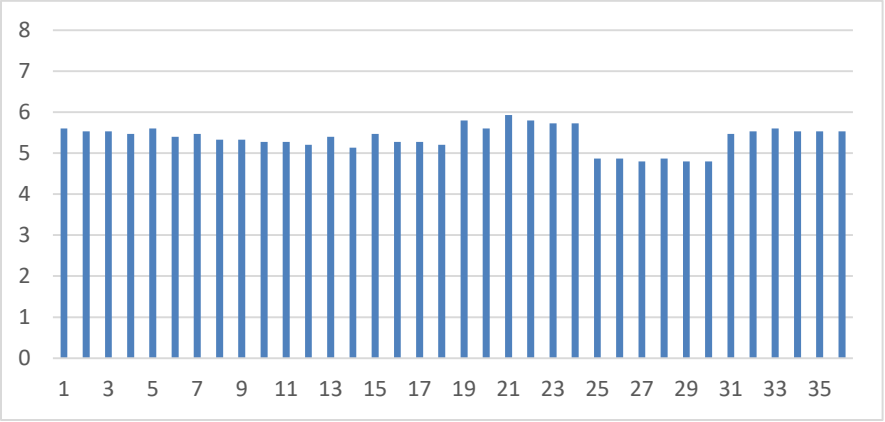

Figure 6. Graphical representation of posttest scores of experimental group

From figure 6, it can be clearly seen that the performance of prospective teachers in experimental group increased more as compared to the teachers of control group. It can be said that the experimental group participants showed interest towards the method of assessment used for concept mapping.

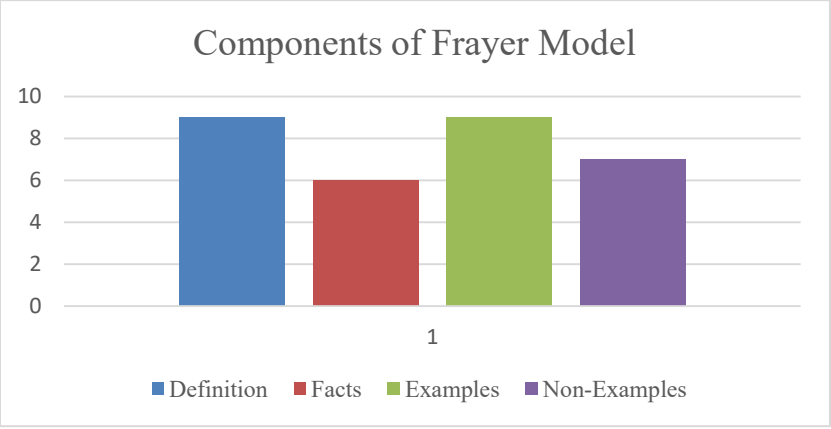

Figure 7. Graphical representation of scores against components of Frayer Model

Figure 7 shows the scores of prospective teachers against each component of Frayer model and it can be interpreted that the teachers scored well against two components equally i.e. definition and examples as compared to other two components.

5. Discussion and Conclusion

The results of the study are evident that treatment group showed better performance as compared to control group which means that Frayer Model had positive effect on the academic achievement of the prospective teachers and they showed interest in the method of assessment used. The achievement of the prospective teachers was increased after assessing them through Frayer Model and it shows that it had positive effect on prospective teachers. The findings of this study were aligned with the findings of the researches carried out to explore the effect of Frayer Model. For instance, Talah (2015) explored in his study that Frayer Model is helpful in increasing the concepts as well as knowledge of students. The studies conducted by Monroe and Penergrass (1997), Talah (2015) and Umi (2020) also investigated that how Frayer Model effect the knowledge development of students and explored that Frayer Model is helpful in improving students' performance. Likely, Nahampun and Sibarani (2014) conducted study that explored that Frayer Model can be used in building vocabulary and concepts of the students by using graphical representation. They further added that Frayer Model can be used to categorize among new and previous knowledge of the students and may also be used as a study aid in educational researches. In early 1974-1975 an experimental research was also conducted by Peters to find out the effect of Frayer model on academic achievement of students by dividing students randomly into two groups i.e. control and experimental and assigned them to read through Frayer Model and traditional way respectively. The results revealed that the group exposed to Frayer Model performed well that supports the findings of this study. Another study conducted by Kimbell and Lopez (2009) also explored that Frayer Model is helpful in increasing the breadth and depth of the knowledge of the students. WETA (2012) also investigated that Frayer Model builds connections among prior and new concepts of the students by creating a visual to compare examples and attributes of concepts and improves the understanding of students. Karjala (2010) also explored in a study that Frayer Model is helpful in developing concepts among students having disabilities in Mathematics and also created motivation for learning among them. Febriyanto (2010) also explored that Frayer Model is helpful in building concepts of students based on their prior knowledge and help them to understand the concept in better way which improves their learning.

Based on the results, it can be concluded that Frayer Model has significant effect on the academic achievement of prospective teachers. The results showed that academic achievement of both the groups were increased however, a significant increase in the performance of students from experimental group occur. The results also explored that academic achievement of prospective

teachers improved during the intervention period and graph showed that performance of students goes upward. It was also explored from the study that components of Frayer Model like definition, facts, examples and non-examples were also improved in their understanding. Although, students scored better in definition and examples than non-examples and facts. Therefore, it can be concluded that academic achievement of prospective teachers improved in the experimental group when they were assessed through Frayer model.

6. Recommendations

On the basis of conclusion, following recommendations were made.

1. As this study is beneficial in developing concepts of students, therefore, it is recommended to use Frayer Model in teacher training institutes as an assessment tool to improve the performance of teachers while developing concepts among them.
2. Curriculum developers and policy makers may get benefit from the findings to incorporate the Frayer Model in curriculum manuals and introduce some assessment exercises based on Frayer Model to improve concepts of readers.
3. Teachers may use this method in their classrooms too to improve the achievement as well as concepts of students in their classes.
4. The research study was conducted on prospective teachers; other researches may be conducted at other levels to explore how much Frayer Model is helpful in concept making and enhancing academic achievement of students.

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