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Development and Evaluation of Concept Maps as Viable Educational Technology to Facilitate Learning and Assessment

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Abstract: **This study had developed and evaluated concept maps as viable educational technology to facilitate learning and assessment. The development process concluded upon establishing validity and reliability. These maps were classified into two: concept maps to facilitate learning; and, fill-in-the-maps to facilitate assessment. A one group pre-test-posttest pre-experimental design was employed. Fill-in-the-maps were utilized for unit pre-tests and posttests. Complete concept maps were used to facilitate learning. For midterm examination, students were given composition as basis for constructing concept map. For final examination, students were provided concept maps to write their own composition. Rubrics were used to assess students' outputs. z-test for correlated means showed significant increases of Mean Percentage Score (MPS) from pre-test to posttest. The overall posttest result was correlated with those of objective, fill-in-the-map, map construction and composition writing. Significant correlations were observed. Results accentuated that concept maps can be developed and evaluated to facilitate learning and assessment.**

Keywords: **concept map development, validity, reliability, fill-in-the-maps.**

1. INTRODUCTION

Educators recognize the usefulness of concept map as educational technology for learning, acquisition of knowledge, as well as assessment. Constructivist educators view it as a tool for the scaffolding of learning. They consider it potential for summarizing students' understandings. They see it as probable support for increasing the efficiency of information retrieval, enhance collaborative learning and increase students' comprehension. Through the use of concept maps, these teachers can put emphasis to the relationship of concepts and propositions and engage students in class activities.

Students' engagement and active participation can be ensured by providing them with valid and reliable concept maps. Through these maps, students are offered with personalized and meaningful experiences of contents. Through this technique, contents can be made meaningful to students. Teachers can do this only if they understand the central concepts and structures of the discipline they teach.

Concept maps as viable educational technology to facilitate learning and assessment can be developed and evaluated. For facilitating learning, concept map can be used to scaffold student's learning. It can also be used to help students construct their own knowledge through group activities. As an educational assessment tool, concept map can help in assessing the structure of students' declarative knowledge. It can facilitate schematic recalling of facts and information. Fill-in-the-map can be employed as authentic assessment strategy for determining the quality of students' understanding.

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These insights have made it imperative for the researcher to conduct this study with the following aims:

1. What is the degree of reliability and validity of the concept maps as viable educational technology to facilitate learning and assessment?

2. What are the extents of students' performance (MPS) in the unit and over-all pre-tests and posttests?

3. Are there significant differences between students' performance (MPS) in Unit and Overall pretest and posttest?

4. What are the extents of students' performance (MPS) in the total fill-in-the-map, total unit objective, overall objective, concept map construction, and composition writing tests?

5. Are there significant correlations among students' Mean Percentage Scores (MPS) in the total fill-in-the-map, total unit objective, overall objective, concept map construction, and composition writing tests?

When concept maps are well developed they can be utilized to assess what students know and can do. They can be viable tools to facilitate learning and assessment. To determine their effectiveness to facilitate learning, pretest can be administered to ascertain what the students already know. After which, concept maps can be presented. Students can formulate propositions or write compositions to answer the focus questions. Discussion can be done to answer students' queries and to facilitate the process of concretizing learning. Posttest may follow as soon as the topic is thoroughly discussed.

The use of concept maps for learning and assessment is supported by learning theories. Ausubel (cited in Novak, 2006) made very important distinction of meaningful learning. In meaningful learning, the material to be learned must be conceptually clear and presented with language and examples relatable to the learner's prior knowledge. The learner must have possessed relevant prior knowledge.

Ausubel, Novak & Hanesian, (cited in Edinson, 2012), designed "meaningful learning theory" as the first systematic model of cognitive learning, whereby learning is necessary to relate new learning from the student's previous ideas. Learners begin to build new knowledge through concepts they already possessed.

David Ausubel (1963; 1968; Ausubel *et al.*, 1978), cited in Novak, et.al. (1983), posit that meaningful learning involves the assimilation of meaningful concepts and propositions into the individual's existing cognitive structure. When relationships are established between or among them, contents become meaningful to students. Concepts and propositions, as well as connections that show relationships, are substantial elements of valid concept maps.

According to Anderson (1992), one of the reasons why concept mapping is so powerful for the facilitation of meaningful learning is that it serves as a kind of template or scaffold to help organize and structure knowledge. Although the structure is built up piece by piece with small units of interacting concept and propositional frameworks, it can be viable tool for facilitating meaningful learning. Bransford, et al. (1999) find out that factual information acquired in a context of meaningful learning is not only retained longer, but this information can be used much more successfully to solve new problems.

There is a need to recognize what concept maps are. According to Novak and Cañas (1986), cited in IHMC (2006), concept maps are graphical tools for organizing and representing knowledge. They include concepts (nodes), usually enclosed in circles or boxes of some type, and relationships (cross-links) between concepts indicated by a connecting line linking these concepts. Words on the line are referred to as linking words or linking phrases. They specify the relationship between these concepts.

Concept Maps can be considered a viable method of learning and assessment. The efficacy studies reveal that when concept mapping is used in a course of instruction, it must be made an integral and on-going feature of the learning process. Interestingly, concept mapping appears to be particularly beneficial when it is used in an on-going way to consolidate or crystallize students' classroom experiences. The framework of the study is presented below:

International Journal of Recent Research in Social Sciences and Humanities (IJRRSSH)
Vol. 3, Issue 1, pp: (204-215), Month: January - March 2016, Available at: www.paperpublications.org

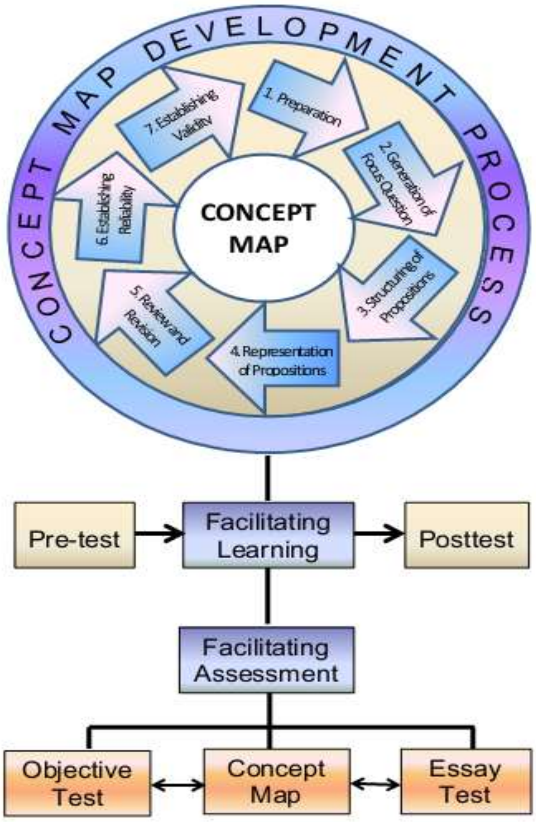

Figure 1: The Schematic Diagram of the Conceptual Framework of the Study

2. METHODOLOGY

This study utilized one group pre-test and posttest pre-experimental design. This design suits the usual classroom situation where students were considered as one group only. Students were pre-tested using objective and fill-in-the-map tests before presenting each unit t. After which discussions were facilitated by using the unit concept map. Unit posttest was conducted using the same tests.

The participants were 274 Third Year Students who belong to six (6) sections. They were considered as one group only. They were oriented about the nature and characteristics of the concept map first before the study was conducted.

The data-gathering instruments were the eight validated concept maps with their corresponding fill-in-the-maps. For objective tests, multiple choice tests were used. These items were taken from the researcher's item bank. The items ranged from easy to difficult.

The eight concept maps were carefully developed. Their development was facilitated through the IHMC Cmap Tools. This software makes it easy for users of all ages to construct and modify concept maps in a similar way that a word processor makes it easy to write text (IHMC, 2006).

The Trochim's (1986) process of preparing concept map was followed. In this process, six steps are involved: 1) Preparation; 2) the Generation of statements; 3) Structuring of statements; 4) Representation of statements in the form of a concept map; 5) Interpretation of maps; and, 6) Utilization of maps.

To establish the reliability of concept maps and fill-in-the-maps, inter-rater and test-retest methods were used, respectively. Twenty Fourth Year Students were requested to come for this purpose which they readily agreed. In the morning, there was a thorough orientation about the characteristics and nature of concept maps. The orientation lasted for three (3) hours. In the afternoon, they were requested to rate the concept maps and answer the fill-in-the-maps. A week later, they were called to answer the fill-in-the-maps again. Test papers for the first and second administrations were scored and scores were encoded.

To establish the validity of concept maps and fill-in-the-maps, expert judgment validity and predictive validity were utilized, respectively. Three colleagues were requested to rate the concept maps independently by using the validation rubrics. They were considered as experts who can judge whether the maps are valid. For fill-in-the-maps, predictive validation was employed. The rating of 20 students in Assessment and Evaluation during the previous year was used as criterion. Their score in the second administration of fill-in-the-maps were correlated with their previous rating.

During the conduct of the study, there were unit (objective and fill-in-the-map) and over-all (objective) pre-tests and posttests administered to the participants. After each unit, data were tallied and organized in Microsoft Excel. Mean Percentage Scores (MPS) were computed. The process was repeated until all unit concept maps were utilized.

During midterm examination, students were required to construct a concept map with a composition as their guide. Focus question was presented in the composition. Rubrics for scoring student's constructed concept map were presented before they started their task. They were required to draw boxes and lines to present relationships between or among concept until they were done with it. The time allotted for this test was thirty (30) minutes. Their outputs were evaluated by using the same scoring rubrics.

During final examination, students were required to write a composition with concept map as their guide. They were required to write the focus question. Rubric for scoring a composition was presented and explained before students started writing. The test lasted for thirty minutes. After which, their papers were gathered. The same rubric was used to score their compositions. Raw scores of the overall objective test, concept map construction during midterm examination, and composition writing during the final examination were tallied and organized.

At the end of the semester, results were analyzed and interpreted. Through this process, the differences between results of pretest and posttest scores were postulated as the effect of the use concept map as viable tool to facilitate learning. If significant difference is observed, then, it can be generalized that concept map is an effective tool for teaching and learning.

In terms of statistical treatments, the researcher utilized the Data Analysis Tools in MS Excel. For establishing reliability of fill-in the map, test-retest (PPM) was used; while for the concept map, inter-rater reliability (Cronbach Alpha) was computed. To establish validity of concept map and fill-in-the-map, expert validation (Mean) and predictive validity (PPM) were applied. For degree of performance in pre-test and posttest, Mean Percentage Score (MPS) was used. For significance of the difference of pre-test and posttest results, the researcher utilized z-test for correlated means. For problems on correlation, PPM was employed.

3. RESULTS AND DISCUSSION

1. On Reliability :

a. of Concept Maps :

The reliability of concept maps was established through the use of inter-rater reliability. Albert & Steiner (2007) posit that a given concept map can be described by attributing specific characteristics or features to the respective map. One procedure is inter-rater reliability; i.e. the consistency of ratings assigned to a concept map. This aspect of reliability can be examined by having two or more judges independently score a given concept map.

Twenty Fourth Year students, who had taken up Assessment and Evaluation, were gathered. An orientation about the nature and characteristics of concept map was conducted in the morning. In the afternoon, they were exposed to the concept maps one at a time. After studying the concept map thoroughly, they were requested to rate each map by using Rubrics. The same process was done all throughout the eight concept maps. Scores were gathered and organized. A multiple correlations were done using MS Excel Data Analysis Tools.

Cronbach Alpha was computed. According to Ritter (2010) Cronbach Alpha is one type of internal consistency coefficient. This coefficient is convenient to calculate because it requires only a single measurement given at one time. This is more practical than other reliability coefficients due to the lack of time and resources to perform the multiple tests seen in test-retest coefficients and the multiple formats seen in form-equivalence coefficients. The degree of inter-rater reliability is shown in Table 1.

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Table 1. The Degree of Inter-rater Reliability of Concept Maps

Concept Maps	No.of Raters	Alpha
Concept Map 1	20	0.936
Concept Map 2	20	0.942
Concept Map 3	20	0.935
Concept Map 4	20	0.959
Concept Map 5	20	0.950
Concept Map 6	20	0.927
Concept Map 7	20	0.904
Concept Map 8	20	0.948

Note: 0.81-1.00, Very High; 0.61-0.80, High; 0.41-0.60, Moderate; 0.21-0.40, Low; and 0-0.20, Very Low

The result showed very high consistency among the ratings of 20 Fourth Year Students for the eight concept maps. This information proves that the concept map has very high degree of consistency; hence, their reliability as viable technology to facilitate students' learning is very high.

b. of Fill-in-the-Maps:

For fill-in-the-maps, test-retest reliability was employed. According to Rico (2011), test-retest method establishes consistency over time. These maps were introduced one at a time after the students were done rating the concept maps. They were requested to fill-in the missing concept or link in the map to complete relationship of concepts. After one week, they were gathered again to answer the fill-in-the-map tests for the second administration. The process was repeated until they were done answering the eight fill-in-the-maps. After which, scoring was done. The results of the first and second administrations were correlated through PPM. The results are presented in Table 2 that follows:

Table 2. The Degree of Test-retest Reliability of Fill-in-the-Maps

Concept Maps	No.of Raters	PPM
Concept Map 1	20	0.786
Concept Map 2	20	0.795
Concept Map 3	20	0.737
Concept Map 4	20	0.788
Concept Map 5	20	0.759
Concept Map 6	20	0.724
Concept Map 7	20	0.805
Concept Map 8	20	0.804

Note: 0.81-1.00, Very High; 0.61-0.80, High; 0.41-0.60, Moderate; 0.21-0.40, Low; and 0-0.20, Very Low

The data in Table 2 shows that the coefficients of correlation of the first and second administration of the eight concept maps were all very high. The data points to the fact that the fill-in-the-maps have high degree of consistency over time. Therefore, they can be used to facilitate assessment of students' learning. According to *Himangshu (2010)*, the use of fill-in-the-map formats for large scale assessment in science education, a combination of both techniques select-and-fill-in and create-a-map techniques must be used in concert as formative and summative assessment tools, providing complementary information about the content and quality of student learning.

2. On Validity:

a. of Concept Maps:

The validity of concept maps was established through expert validation. This validity method is also known as judgment validity. Experts in the field were consulted. They judged whether the concept maps have face, construct and content validity. According to Berk (1990), expert professional judgment should play an integral part of developing the definition of what is to be measured, such as describing the universe of content, generating or selecting the content sample, and specifying the item format and scoring system.

The concept maps were presented to two experts in Language. They were chosen to be validators because concept maps contain propositions – relationship among concepts. Through their language expertise, they provided some suggestions to improve the concept maps. Another validator was a colleague who has been teaching the same subject. His expertise was so important. He suggested what concepts to be included in the concept maps. Rubric for Evaluating Concept Map was used for rating the maps. The result of their validation is presented in Table 3.

Table 3. The degree of Expert Validity of Concept Maps

Concept Maps	Rater 1	Rater 2	Rater 3	Mean
Concept Map 1	2.80	2.90	3.00	2.90
Concept Map 2	2.90	3.00	2.90	2.93
Concept Map 3	3.00	2.90	3.00	2.97
Concept Map 4	2.70	2.80	2.80	2.77
Concept Map 5	2.90	2.90	2.90	2.90
Concept Map 6	2.90	2.80	2.83	2.83
Concept Map 7	2.90	3.00	2.93	2.93
Concept Map 8	2.80	2.90	2.90	2.87

Note: 2.61-3.00, Very High; 2.21-2.60, High; 1.81-2.20, Moderate; 1.41-1.80, Low; and 1.00-1.40, Very Low

Table 3 showed that there is very high degree of validity as judged independently by the raters. This means that all experts were unanimous in their ratings – very high. Therefore, the concept maps have very high degree of validity. This result shows that all experts agreed that the eight concept maps are valid educational technology to facilitate students' learning.

This finding is in line with the concept of Primo, et.al. (1997) that an averaged experts' structure can be considered for defining the structure of the domain. This may reduce the problem of variability among experts and provide a better picture of the structure of the content domain of concept maps.

b. of Fill-in-the-Maps:

The researcher also established the predictive validity of concept maps. Predictive validity is the "power" or usefulness of test scores to predict future performance. As Rico (2011) puts it, if the test results match with previous performances (criterion), then it can predict future performance.

Students were required to answer the fill-in-the-map with concepts or links needed to complete the propositions. By using scoring key, scores were determined. These scores in every fill-in-the-map were correlated with their previous rating in Assessment and Evaluation. The analysis of the data gathered is presented in Table 4.

Table 4. The Degree of Predictive Validity of Fill-in-the-Maps

Concept Maps	No. of Participants	PPM
Concept Map 1	20	0.817
Concept Map 2	20	0.683
Concept Map 3	20	0.855
Concept Map 4	20	0.852
Concept Map 5	20	0.850
Concept Map 6	20	0.601
Concept Map 7	20	0.701
Concept Map 8	20	0.819

Note: 0.81-1.00, Very High; 0.61-0.80, High; 0.41-0.60, Moderate; 0.21-0.40, Low; and 0-0.20, Very Low

Table 4 shows that the degree of predictive validity of Fill-in-the-Maps ranged from marginal high to very high. Fill-in-the-map 6 has only 10 items. It has been an accepted view that the longer the test, the higher is the index of reliability. This only shows that concept maps have acceptable degree of reliability as educational technology to facilitate assessment of learning.

International Journal of Recent Research in Social Sciences and Humanities (IJRRSSH)
Vol. 3, Issue 1, pp: (204-215), Month: January - March 2016, Available at: www.paperpublications.org

As cited in Himangshu (2010), very few studies have compared the reliability estimates of different scoring systems. Much of the work on the reliability estimates of scoring have involved comparison of two different or similar mapping formats, such as comparison of open-ended map construction with fill-in-the-map format (Ruiz-Primo et al., 2001) or comparison of two type of fill-in the map formats (Yin & Shavelson, 2005). McClure and colleagues (1999) reported a significant piece of research comparing six different types of scoring methods.

3. On Over-all Pre-test and Posttest:

a. Extent of Performance (in MPS):

The over-all test is a 75 item multiple choice test. Pre-test was conducted at the beginning of the semester. Posttest was at the end. Scores were tabulated and organized in MS Excel. Students' Mean Percentage Scores were analyzed to show the extents of performance.

Table 5 presents the extents of performance of students in the overall pretest and posttest. During their pre-test, the result was low while in the posttest, it shows high performance. This increase is the effect of the use of concept map to facilitate learning.

Table 5. The Extent of Performance in the Overall Pretest and Posttest

Overall Test	MPS	sd
Pre-test	34.79	6.34
Posttest	78.65	11.17
Difference	43.84	

Note: 80.01-100.00, Very High; 60.01-80.00, High; 40.01-60.00, Moderate; 20.01-40.00, Low; and 0-20.00, Very Low

b. On Significant Difference of Performances:

Significance of the difference between pre-test and posttest results was determined through z-test for correlated means. The data on Table 6 proves that there is significant difference (z=6.94) in the results of two tests. There was a marked increase from low to high degree of performance from pre-test to posttest, respectively.

Table 6. The Significance of the Difference between Over-all Pre-test and Posttest

Overall Tests	MPS	Mean Diff.	sd_{dm}	z-value
Pre-test	34.79	43.84	6.32	6.94*
Posttest	78.64			
N=274				

Note: Reject H_o, if $z \geq 1.96$

This result manifests that concept map is effective when used to facilitate learning. It can create knowledge frameworks that allows for information to be retained in their long-term memory. The creation of powerful knowledge frameworks does not only permit utilization of the knowledge in new contexts, but also the retention of the knowledge for long periods of time (Novak, 1990; Novak & Wandersee, 1991).

The "gestalt effect" of concept maps allows viewing many concepts at once; increasing the probability of identifying gaps and making new connections. Generating concept maps requires learners to represent concepts in a new form… (Bjork & Linn, 2006 ; Linn, Chang, Chiu, Zhang, & McElhaney, 2010) - a condition that introduces difficulties for the learner which slow down the rate of the learning and can enhance long-term learning outcomes, retention, and transfer (Schwendimann, 2014).

4. On Unit Pretests and Posttests:

a. Degree of Unit Fill-in-the-Map Pre-test and Posttest Performance:

Unit pretests were conducted before actual discussions using concept maps. Scores in fill-in-the-map were tallied and organized in MS Excel. Some content areas took several meetings to finish. Concept maps were used to concretize concepts and ideas. Students were required to write their journals and compositions with concept map as guide.

At the end of the unit, posttest was administered. Scores were tallied together with their pre-tests. Mean Percentage Scores were computed to determine students' extents of performance. The data is presented in Table 7.

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Vol. 3, Issue 1, pp: (204-215), Month: January - March 2016, Available at: www.paperpublications.org

Table 7. The Extents of Unit Fill-in-the-Map Pretest and Posttest Performance

Fill-in-the-Map Unit Tests for:	Tests	MPS	Sd
Cmap1	Pre-test	19.10	6.82
	Posttest	70.75	15.58
Cmap2	Pre-test	24.94	7.64
	Posttest	77.30	14.10
Cmap3	Pre-test	24.45	8.34
	Posttest	76.50	14.95
Cmap4	Pre-test	25.69	6.68
	Posttest	77.18	13.40
Cmap5	Pre-test	25.84	6.48
	Posttest	77.86	11.73
Cmap6	Pre-test	25.36	9.22
	Posttest	79.96	10.67
Cmap7	Pre-test	25.57	6.19
	Posttest	79.83	10.47
Cmap8	Pre-test	26.25	5.90
	Posttest	80.32	9.43

Note: 80.01-100.00, Very High; 60.01-80.00, High; 40.01-60.00, Moderate; 20.01-40.00, Low; and 0-20.00, Very Low

The information shown in Table 7 points that from the Low pre-test results there was a marked increase to High posttest. This finding is supported by Novak (2010, p.60), that students actively "integrate new information with existing relevant information" in their minds. This type of meaningful learning helps to enhance the retention of new concepts as well as enable the future application of such concepts to new situations (Novak 2010, cited in Boucquey, 2015).

The aforementioned findings are corroborated by Akay, et.al (2012) study. They investigated on the Effects of Concept Maps on the Academic Success and Attitudes of 11th Graders while Teaching Urinary System. Their findings point that the cognitive support of the concept maps had a positive impact on students' achievement and retention of knowledge. The data furthermore indicated that students have a positive attitude for concept maps.

b. Significant Differences of Fill-in-the Map Unit Pre-test and Posttest:

One of the aims of this study was to determine whether there will be significant effect when fill-in-the-maps are used to facilitate assessment. To achieve its purpose, pre-tests and posttests were administered and results were gathered, organized and interpreted.

The z-test for correlated means was computed. Significant differences exist between the unit pre-test and posttest results. Table 8 showed that there is a marked increase of students' MPS from pre-test to posttest.

Table 8. Significance of the Difference between Unit Pre-test and Posttest for Fiil-in-the-Map

Fill-in-the-Map Unit Tests for:	Mean MPS Pretest	Mean MPS Posttest	Mean Diff.	sd_{dm}	z-value
Cmap1(N=271)	19.10	70.75	51.65	11.12	4.64*
Cmap2(N=273)	24.94	77.30	52.36	11.89	4.40*
Cmap3(N=269)	24.45	76.50	52.04	12.14	4.29*
Cmap4(N=269)	25.69	77.18	51.48	11.25	4.58*
Cmap5(N=272)	25.84	77.86	52.02	9.93	5.24*
Cmap6(N=273)	25.35	79.96	54.60	10.16	5.37*
Cmap7(N=273)	25.57	79.83	54.26	8.74	6.21*
Cmap8(N=274)	26.25	80.32	54.06	7.60	7.11*

Note: Reject H_o, if $z \geq 1.96$

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This finding highlights the effect of concept map as viable educational technology to facilitate learning, when fill-in-the-map was used to assess learning. The results suggest that in addition to the use of fill-in-the-map formats for large scale assessment it can also provide complementary information about the content and quality of student learning (Himangshu, 2010).

c. Degree of Unit Pre-test and Posttest Performance in Objective Tests:

Students' scores in objective tests were tallied and organized in MS Excel. Some content areas took several meetings to finish. Concept maps were used to concretize concepts and ideas. At the end of the unit, posttest was administered. Scores were tallied. Mean Percentage Scores were computed to determine students' degree of performance. The data is presented in Table 9.

Table 9. The Extents of Unit Objective Pretest and Posttest Performance

Objective Unit Tests for:	Tests	MPS	Sd
Cmap1	Pre-test	25.52	9.37
	Posttest	78.76	12.03
Cmap2	Pre-test	29.27	8.63
	Posttest	78.32	12.77
Cmap3	Pre-test	28.66	9.81
	Posttest	77.88	15.67
Cmap4	Pre-test	31.44	10.91
	Posttest	80.39	13.93
Cmap5	Pre-test	31.29	9.84
	Posttest	81.34	11.78
Cmap6	Pre-test	33.10	10.53
	Posttest	81.82	12.91
Cmap7	Pre-test	33.04	9.20
	Posttest	83.58	11.31
Cmap8	Pre-test	34.18	9.01
	Posttest	85.45	9.87

Note: 80.01-100.00, Very High; 60.01-80.00, High; 40.01-60.00, Moderate; 20.01-40.00, Low; and 0-20.00, Very Low

Data in Table 9 showed that there were marked increases in students' MPS from pre-test to posttests in objective tests. During their pre-tests, MPS was low; however, in the posttest, the extent of performance ranged from high to very high.

Chiou (2008) investigated on the effect of concept mapping on students' learning achievements and interests. The study described that concept mapping can be used to help students improve their learning achievement and interests.

d. Significant Differences between Objective Unit Pre-test and Posttest:

One of the aims of this study was to determine whether or not significant differences between students' MPS in the objective pre-tests and posttests. Data were gathered, tabulated, organized and analyzed.

Table 10 presents the information about the significance of the difference between the results of pre-test and posttest MPS for the objective unit tests. It shows that there are significant differences between pre-test and posttest results.

Table 10. Significance of the Difference between the Objective Unit Pre-test and Posttest

Objective Unit tests for:	MPS Pretest	MPS Posttest	Mean Diff.	sd_{dm}	z-value
Cmap1(N=271)	28.52	78.76	50.24	8.48	5.92*
Cmap2(N=273)	29.27	78.32	49.05	9.83	4.49*
Cmap3(N=265)	28.66	77.88	49.22	11.91	4.13*
Cmap4(N=272)	31.44	80.39	48.95	12.54	3.90*
Cmap5(N=272)	31.29	81.34	50.05	8.71	5.74*
Cmap6(N=268)	33.10	81.82	48.72	10.46	4.66*
Cmap7(N=271)	33.04	83.58	50.54	10.04	5.04*
Cmap8(N=274)	34.18	85.45	51.27	8.10	6.33*

Note: Reject H_o if $z \geq 1.96$

Findings in Table 10 show that there were significant differences between students' MPS in their unit objective pre-tests and posttests. This goes to show that objective tests can gather information similar as how fill-in-the-map tests can. This match between two types of test illustrates that both types of test can be utilized for assessing learning.

5. On the Extents of Performances in Total Fill-in-the-map, Total Objective, Overall Objective, Concept Map Construction, and Composition Writing Tests:

The total fill-in-the-map, total objective, overall objective, concept map construction, and composition writing tests were tabulated and analyzed. The extents of students' performance (in MPS) were determined.

Table 11 shows that there is high extent of students' performance in the five types of test conducted to students. This finding highlights that Fill-in-the-map is as effective as other types of test for facilitating classroom assessment.

Table 11. The Extents of Performance in the Five Types of Test

Tests	MPS	sd
Total Fill-in-the-Map	77.25	10.34
Total Objective Unit	80.90	10.16
Overall Objective	78.64	11.17
Map Construction	77.65	10.04
Composition Writing	79.76	11.98

Note: 80.01-100.00, Very High; 60.01-80.00, High; 40.01-60.00, Moderate; 20.01-40.00, Low; and 0-20.00, Very Low

This finding goes to show that extents of performance for all types of test were similarly high. Fill-in-the-map results matched with those of other types of test.

6. On Correlation among the Five Total Tests:

The computed z-tests for correlation among the five total tests, significance of their correlations by pair was shown. Interestingly, Fill-in-the-map test and unit objective tests have the highest z-value (61.69). These findings point to the fact that whatever students learn as they complete the map may have impact in their long-term memory. Information becomes clearer when they are aided with concept map.

Table 12. Significance of the Correlation among the types of test

Pair No.	Tests	Coefficient of Correlation	z-value
1	Total Fill-in-the-Map vs. Total Unit Objective	0.966	61.69 *
2	Total Fill-in-the-Map vs. Overall Objective	0.848	26.57 *
3	Total Fill-in-the-Map t vs. Map Construction	0.878	30.36 *
4	Total Fill-in-the-Map t vs. Composition Writing	0.835	25.13 **
5	Total Unit Objective vs Overall Objective	0.824	24.13 *
6	Total Unit Objective vs. Map Construction	0.863	28.63 *
7	Total Unit Objective vs. Composition Writing	0.822	23.91 *
8	Overall Objective vs. Map Construction	0.838	25.46 *
9	Overall Objective vs. Composition Writing Test	0.799	22.07 *
10	Map Construction vs. Composition Writing	0.895	33.26 *

Note: Reject $H_{o,}$ if $z \geq 1.96$

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This finding highlights that all types of test were significantly correlated. It can be gleaned from this result that fill-in-the-map test is not inferior to traditionally utilized assessment tools.

4. CONCLUSIONS AND RECOMMENDATIONS

Findings of the study become valuable information for classroom teachers and educators. Concept maps can be developed and evaluated. Concept Mapping tools are available online. They are ready for use. Validity and reliability of concept maps to facilitate learning and assessment can be established.

There were increases in students' performance from pre-test to posttests - clearly manifesting effectiveness of concept maps. Researcher's self-reflection was that concept map has really facilitated the teaching-learning process. It has potential for making learning meaningful to students. It was observed that students' engagement in classroom activities was so remarkable.

Consistently, from first to the last concept map, there were significant increases in students' MPS. It is a fact which proves the effectiveness of concept maps. The consistency of this increases in MPS points to reality that concept maps can be utilized as viable tools to facilitate learning.

Notably, fill-in-the-maps can be used to facilitate assessment. It had remarkably matched with results of objective tests, concept map construction, and composition writing tests. This finding illustrates that fill-in-the-map assessment technique can be as effective a objective tests.

Noticeably, there are significant correlations among the five types of test used for assessment. The advantage to fill-in-the-map technique lies in its ability to differentiate between rote learning and conceptual learning, since rote learning is readily forgotten; conceptual understanding (even superficially) is required for connecting propositions. A more pertinent advantage of fill-in-the-map techniques is the reliability with which they can be scored when compared to the expert map (Himangshu, 2010).

Therefore, it is recommended that teachers, at any level, should learn how to use the IHMC Cmap Tools for developing concept maps in their specific discipline. When carefully developed, they can include these in the pool of educational technology readily for use when necessity comes. It is further recommended that a more effective and simple method of establishing validity and reliability must be introduced.

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