

Preferred Contexts in Learning Number Concepts Integers in The Intermediate Phase Addition and Subtraction: Focus on Three Intermediate Phase Learners in Johannesburg North District

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Abstract

The focus of the study is to apply the mapping method to innovate curriculum design. The purpose is to explore how to use the teaching method concept mapping to help learners build scaffolding, so that learners can organize scattered knowledge and construct meaningful integer knowledge through concept mapping. In other words, it helps the intermediate phase learners to present integer abstract concepts in a practical way and show the interrelated concepts and facts when working with integers. Concept mapping is regarded as a powerful tool for teaching Science and this study explores how effective the concept mapping skills can be used in exploring Mathematical concepts such as integers. The analysis of this paper is done using the Blooms Taxonomy.

Keywords: Integers • Concept mapping • Positive numbers • Negative numbers

Introduction

Many researchers have examined the positive effects of using the concept mapping in teaching science and mathematics [1-3]. These researchers agree that concept mapping helps learners to focus on important, concepts, and helps the learners to grasp the interrelatedness between these concepts. The use of concept mapping is supported by Kichini and Reiska [4] who maintain that concept maps have shown a positive impact on the quality of student learning in a variety of disciplinary contexts and educational levels from primary schools to universities. A Concept Map (CM) is a graphic representation of the relationship between the concepts and the processes related to a particular subject area. The (CM) consists of different nodes (concepts) and their relationships, or edges.

The meaning of concept mapping

Concept mapping was the brain child of Novak [5], who proposed that concept maps are tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts or propositions, indicated by a connecting line between the concepts. Concept maps take different structures, some are hierarchical, some are inter-linked and cross-link, these were developed based on learning the Psychology of Ausubel [6].

The concept map is one of the powerful tools for learning and evaluation and encourages the learners to experience more meaningful learning patterns [2,7,8]. Concept mapping is a process of cognitive structure and development in a symbolic construction in simple and complex inter-related structures.

The concept mapping originated from the Ausubel's [6] meaningful learning theory and they emphasize the connections among concepts that

individual's knowledge structure and in this theory there are three elements useful for the development of the mapping method:

- Firstly, construction of new knowledge involves conceptual connections between new information and prior, secondly hierarchically organized cognitive structure are more general concepts and where higher level in hierarchy and less general are positioned under the more general concepts and meaningful learning takes place when relationships are explicit and are better integrated with each other in propositions [4,5].
- Concept mapping has an instructional design philosophy which comprises of teaching objectives, scaffolding and learning strategy strategies through sharing. Ho-Wang suggests that the design philosophy of concept mapping helps in the acquisition of three levels namely improving learners' academic performance, guide on the use of concept mapping and the ability to understand the composition of concepts and relationships.
- The learner provides examples or demonstrates and illustrates the understanding of the concept and it is useful for learners to master the types of patterns by practice and study in different subjects. The concept mapping concept helps in reflection and discussion, guides to revise and refine concepts sharing ideas and finding out the grey areas.

The nature of concept mapping as described above makes it a powerful tool for teaching and testing researching learner understanding. Research has shown that this tool has mostly been used in science education (chemistry, biology and physics). In this study MC is used to explore mathematical knowledge understanding in a qualitative way as was previously practiced by Mwakapenda [2].

Study design

This study involved intermediate phase learners from one selected school in Johannesburg North District in Gauteng Province. There are three groups of learners. Three learners were introduced to the topic integers. The instruction used the following words:

- Integers
- Positive numbers
- Negative numbers

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- Number line
- Zero
- Altitude
- Owing
- Game
- Greater than
- Smaller than
- Minus
- Count on
- Count back

Erry, a girl, aged eleven years from Grade 6, a boy, Why, who is from Grade 5 who is ten years old and Carl, a girl, aged 10 from grade 5. The learners were asked to demonstrate their understanding of given integer concept using concept mapping and an analysis of the responses was done by the researcher. The researcher first transcribed the work of the three learners and then examined the points demonstrated in mapping by the different learner one at a time. The learners drew up a concept map and were also interviewed explaining unclear sections of the concept map in the interview.

Data Collection

Concept mapping: integers-Erry

In an interview with Erry (pseudonym) she is asked:

- How do you explain the concept integer related words in your mapping? What are the concepts connected to integers?
- How these concepts connected to integers?
- What are the connections of these words and integers?

Integers: The ideas stem from the word integers in the middle of the concept map. The words are all placed in a box and connected to the main idea by lines. Some words are connected directly to the central main concept and some are in directly connected to the central idea. According to the work produced by Erry, integers are numbers that are before and after zero. They are positive and negative numbers and zero is neither positive nor negative and zero is the central point.

Positive numbers: Following the excerpt given by Erry the positive numbers are +1; +2 and +3 and so on.

Negative numbers: Following the excerpt given by Erry the negative numbers are -1; -2 and -3 and so on.

Number line: According to Erry the number line is a line with markings but it does not have positive and negative numbers. This seems to be clearly shown on count back and count on where the number line has correct positive and negative integers in position.

Zero: Zero has been described as the central point where by zero is neither positive nor negative.

Owing: According to the concept map for Erry after borrowing you owe.

Altitude: Erry mentions ground floor and altitude.

Game: Erry states that in games it borrowing and owing.

Greater than: According to Erry, in her work $+1 < +2$, she used the smaller than sign instead of the greater than. The statement could have been 2 is greater than 1.

Smaller than: Gathering the ideas from Erry in the concept map $+2 >$

-1, the sign is bigger than and it is not facing the correct position

Minus: Minus/subtract $+5-7 = -2$.

Count on: According the work produced by Erry counting back is +1; +2; +3 and so on. This excerpt shows the correct counting on with correct intervals.

Count back: According the work produced by Erry counting back is +1; 0; -1; -2; -3 and so on. This excerpt shows the correct counting back with correct intervals.

Concept mapping: integers-Why

The mapping was transcribed following the interview with Why (pseudonym) and the analysis followed the order of the given words.

Integers-positive numbers-negative numbers: According to the excerpt above, words are placed in bubbles and connected by lines. As shown in the excerpt, integers are positive and negative numbers. There are positive and negative numbers. Why connects the positive numbers +1; +2; +3 and so on. The negative numbers are listed as -1; -2; -3; -5 and up to -10. The central idea stems from the word integers colored red.

Number line: The number line is placed on the top. The number line is recorded as NumbER LinE with number ranging from -10 to +10 as follows (-)10;9;8;7;6;5;4;3;2;1;0;1;2;3;4;5;6;7;8;9;10 (+), the positive and negative signs are placed at the beginning and at the end.

Zero: The excerpt produced by Why has nothing said about the zero.

Owing: The MC shows the word owing and after the word there is $-2=4$ and the words you owe R4,00. From the concept mapping, what can be owed is money only as further explained $-5-5 = R10,00$. You owe R10,00.

Altitude: The excerpt produced by Why has nothing said about the Altitude.

Game: The excerpt produced by Why has nothing said about the game.

Greater than: The concept mapping of Why provides the word greater than and explains as $+7 = -7$, the concept map shows equal sign instead of the greater than. It could however $+7 > -7$ and the concept map is further explained by $+8 > -1$. The excerpt seems to be mixing ideas.

Smaller than: The excerpt produced by Why has nothing said about the smaller than.

Minus/count back: The excerpt produced by Why shows the word minus followed by $+6-6=0$, this shows Why can interpret the signs and operations for this one and $+10-3=-7$ the excerpt shows confusion in the use of signs because the expected answer is +7 and in the last one $0-7=-7$ is relevant, appropriate and correct.

Plus: According to the concept mapping of Why plus $-6+6=0$, this shows that Why understands the word plus and the operations, then $-3+10=+7$ shows Why does not have challenges in adding integers and the last one is $-7+0 = -7$.

Concept mapping: integers-Carl

Integers: According to the concept mapping of Carl places the main concept in the middle of the map. It is colored red.

Positive numbers: The mapping shows positive numbers that written in a rectangular block and these are +1, +2, +3, +4, +5, +6 and +7.

Negative numbers: Carl gives a list of negative numbers as -1, -2, -3, -4 and -5.

Zero: According to Carl zero is in the middle of the number line and one cannot minus zero.

Owing: Carl shows that one gives back what has been borrowed.

Altitude: According to the concept map provided by Carl the altitude is

illustrated by "0" being the ground floor, then going up +1, +2, +3 and so on. It seems underground is also shown by -1, -2 and -3.

Game: According to the mind map integer learning is like a game.

Greater than: Carl views numbers and compares them using statements for example she states that 8 is greater than 7 and carries on to state that 7 is smaller than 8 hence the word (smaller than) has been included in the concept map.

Minus: According to the concept mapping $2-1=1$ and this is interesting.

Count on: The concept map shows counting on in ones.

Count back: The concept map shows counting back in ones as it shows 4, 3, 2, and 1.

Data Analysis

Many concept studies have shown predominant qualitative analysis of the concept maps and continues to score different aspects of the maps as the presence of hierarchy, in this paper I examined the use of all given words, propositions of hierarchy levels, links and examples, cross links and specific examples related to the links.

The maps were examined to determine whether learners considered all concepts. The central concept integers in developing the links and developing other sub-concepts. The excerpts provided by three learners were transcribed by the researchers and then examined following the blooms taxonomy. The meanings and explanations linking the concepts raised questions on the understanding of specific hanging concepts. The main question is how effective are concept maps in teaching mathematics in the intermediate phase? The article seeks to find out the effectiveness of concept mapping approach on select cognitive and affective correlates in learning integers in the intermediate level as was done by Joseph and according to the Blooms Taxonomy [9,10].

Analysis of the learners' concept maps

Detailed analyses and findings related to the learners' concept maps are presented. In this article, the analysis focuses on the maps drawn by (pseudonyms) Erry, Why and Carl.

An analysis of Erry's concept map

In this section in this article the analysis focuses on the p drawn by Erry, a learner in the intermediate phase in the Mathematics lesson. In the discussion that will follow, some implications arising from the analysis the data of Erry are described discussed in the context of the in the Blooms Taxonomy [10,11] in Table 1. Figure 1 shows the Erry's concept Map.

In relation to the given task and in quantitative terms we can see from Figure 1 that Erry used all the words given in the concepts. Erry identified and listed 12 out of 12 words. We can see that there is a Title-Mind Map-Integer concept. The mind map clearly indicates the central idea Integers colored in deep blue. In the mind map two distinct features can be seen and these are boxes and connecting lines. According to the work produced by Erry, integers are positive and negative numbers other than zero. Qualitatively in comparison with the top part, the bottom of the mind map is organized around a central concept. It can be described as a cluster assemblage of concepts. However, the fact that Erry drew a concept map that she saw that there were links between various concepts and she was able to display these links as could be seen on Figure 1.

It could be seen that the concept of integer was used twice, firstly as a central idea and secondly as an explanation, it appears Erry has identified the word integers, explained the concept of integer and lastly gave examples of integers. Erry shows knowledge of integers, comprehension of integers and application of integers (Bloom's Taxonomy level 1, 2 and 3) as observed from Figure 1 above.

The concept map shows all words listed (Level 1) for example positive

numbers are given as +1; +2 and +3. The concept map shows the words positive numbers and examples of positive numbers, Erry could identify the words positive numbers and the concept map exemplifies part of the integer concept (B.T levels 1, 2 and 3) are covered a correct way. The concept map identifies negative integers and examples -1, -2 and -3 are given. This suggests that Erry identifies how positive and negative numbers are linked to the central concept integers. As can be seen on the concept map, Erry described positive and negative numbers explaining from the central concept in the concept map.

Erry wrote the word number line. The concept map shows a number line however in this instance Erry provides an empty number line with no positive or negative numbers. In this section Erry could identify the word number line but could not give a complete number line with positive and negative numbers perhaps Erry operated of (B. T level 2). She could remember the number line but could not give examples of the numbers. The concept map shows that zero is connected to integers. The MC shows that zero has been described as the central point where by zero is neither positive nor negative. The explanation given by Erry represents level 5 as

Table 1. Six levels of Blooms Taxonomy.

Level 6	Create	Produces new or original ideas. Design, assemble, construct, conjecture, develop, formulate,investigate
Level 5	Evaluate	Justify a stand or decision. Praise, defend, argue, judge, select, Support, value, critique, weigh
Level 4	Analyze	Draw connections among ideas. Differentiate, organize, relate, Compare, contrast, distinguish, Examine, experiment, question
Level 3	Apply	Use information in new situations. Execute, implement, solve, use, Demonstrate, interpret, operate, schedule.
Level 2	Understand	Explain ideas and concepts. Classify, describe, discuss, explain, identify, locate, recognize, Report, select and translate
Level 1	Remember	Recall facts and basic concepts. Define, duplicate, list, memorize, state, repeat, state.

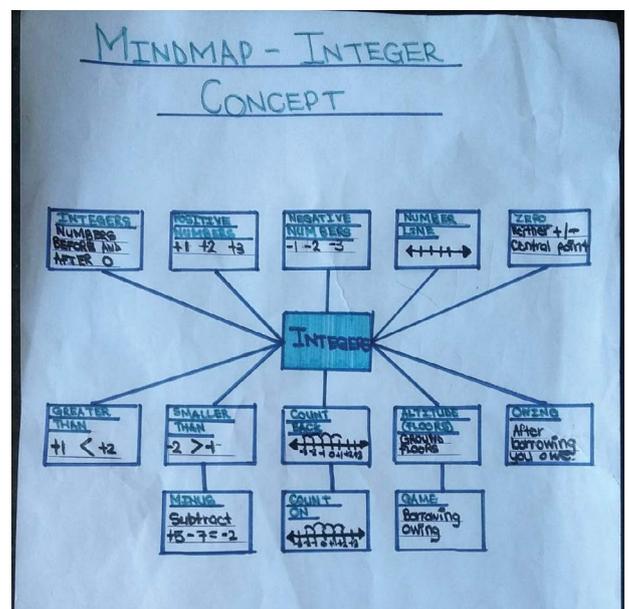


Figure 1. Concept structure of Erry.

she says its neither a positive nor a positive number, hence it is not an integer because of this justification.

The concept map shows that According to Erry, in her work $+1 < +2$, she used the smaller than sign instead of the greater than. The statement could have been 2 is greater than 1. Erry has a basic idea of smaller than, she knows the sign but in this one she lands into BT level 1. She does not understand the signs. Observing from the concept map Erry has challenges with bigger than and smaller than shown in Figure 1 as follows $+2 > -1$, the sign is bigger than and it is not facing the correct position. Gathering the ideas from Erry in the concept map she is in B.T level 1.

The concept map provided by Erry counting back with integers was demonstrated clearly as $+1; 0; -1; -2; -3$ and so on. This excerpt shows the correct counting back with correct intervals. According to the work produced by Erry counting back is in BT level 4. She identified count back and gave examples of a correct count back.

The words altitude as linked to integers and ground floor were given in the original words but it seems the Concept Map does not have much substance on these two. The concept map states or mentions ground floor and altitude without detailed information. This leaves Erry on B.T. level one as she could not identify the relevance of these two in the link with integers. The concept map shows no clear cut explanation on Games and owing. These could be placed in BT level one as Erry's concept map has no substance on these. The following is an analysis for Why.

Analysis of the Why's concept map

The mapping was transcribed following the interview with Why and the analysis followed the order of the given words. Figure 2 shows the concept mapping provided by Why. Figure 2 in the concept mapping does not have a topic like the one provided by Erry in Figure 1. Why seems to list all the words linked to the concept integers and then selects one word at a time for usage in the concept map. Although words are copied, Why seems to miss some of the spellings for example the word "Integers" and "negitive" are not correctly spelt. The concept map begins with a list of words and a central concept in the middle of the concept map. Figure 2 shows bubbles and line connections linking the concepts.

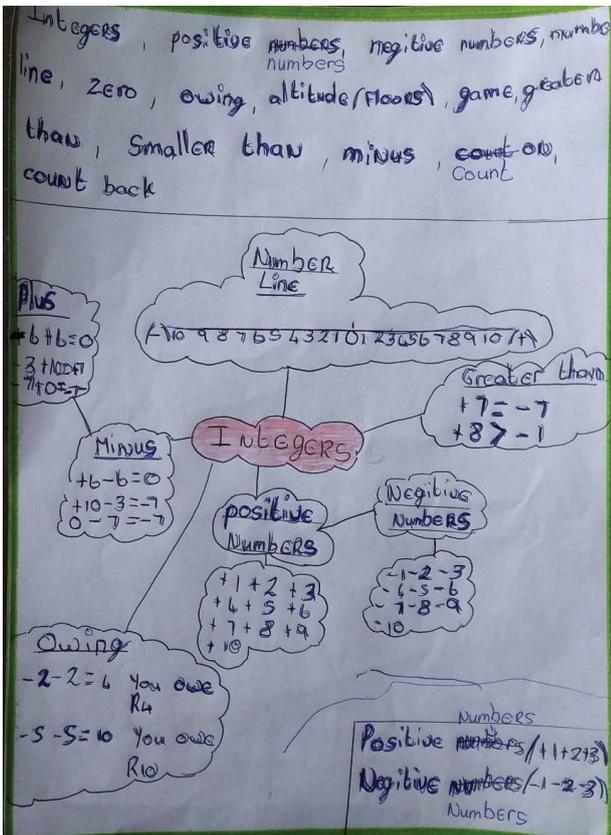


Figure 2. Concept structure of Why.

The concept map provided by Why in Figure 2 has 10 out of 12 concepts recorded and only ten were explained in the concept map. As we can see Why has challenges in spellings and lettering is mixed up, capital letters and small letters are written anyhow. In this section we are exploring how Why gave his concept map and interpret the concept map.

Although the concept map shows the concept integer as the central concept, it is wrongly spelt as previously explained. According to the Figure 2, words are placed in bubbles and connected by lines. The concept explains that integers are positive and negative numbers. There is further explanation such as positive and negative numbers. Why connects the positive numbers $+1, +2, +3$ and so on. The negative numbers are listed as $-1, -2, -3, -4$ and up to -10 . The central idea stems from the word integers colored red. Disregarding the spelling issue the work provided by Why is in B.T level 4 because he, identifies the connected concepts correctly and gives examples of positive and negative numbers with a correct explanation.

The concept mapping provided by Why shows that the number line is connected to the concept of integers. As we can see from Figure 2, the number line is placed on the top. The number line is recorded as 'Number Line' with number ranging from -10 to $+10$ as follows $(-10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10(+))$, the positive and negative signs are placed at the beginning and at the end. Corresponding to the work given by Why would be in B.T level 3 as he could not give correct examples of positive and negative integers correctly.

Connecting to the concept map given by Why there are some concepts which were in the bubbles connected with lines but nothing of substance was given for example the zero was written in the words above but no explanation was given in the concept map. The word altitude was written on top but no explanation was given in the concept map, it seems there are challenges in including all the words in the correct order and spellings. The concepts in this section would obtain level 1.

The concept map given by Why shows comparisons of integers. Corresponding to concept mapping of Why provides the word greater than and explains as $+7 = -7$, the concept map shows equal sign instead of

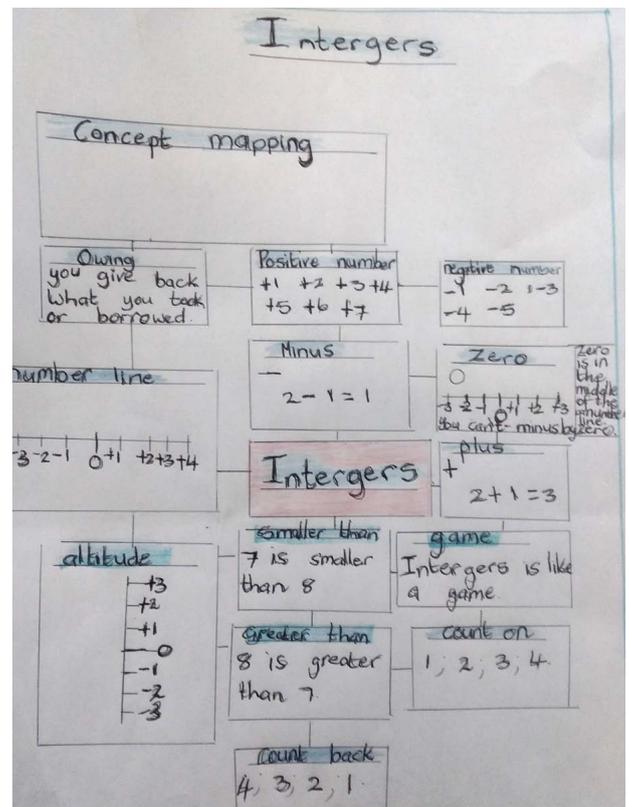


Figure 3. Concept Structure of Carl.

the greater than. It could however $+7 > -7$ and the concept map is further explained by $+8 > -1$.

The concept map shows a clear understanding of counting on and counting back of integers. The concept map shows word minus followed by $+6-6=0$, this shows Why can interpret the signs and operations for this one and $+10-3=-7$ the excerpt shows confusion in the use of signs because the expected answer is $+7$ and in the last one $0-7=-7$ is relevant, appropriate and correct. Why could be given B.T. level 4 because he remembers integers, understands integers, applies and can analyze integers.

Analysis of the Carl's concept.

The concept map provided by Carl begins with a topic on to labelled "integers the concept map has words placed in a block and they are connected by lines." concept mapping and the word integers is spelt intergers' in the concept map. Carl's concept map included all the given words given to be used in the concept map.

According to the concept map show positive numbers that written in a rectangular block and these are $+1, +2, +3, +4, +5, +6$ and $+7$ and the concept map shows negative numbers.

Carl gives a list of negative numbers as $-1, -2, -3, -4$ and -5 . The concept map provided can place in Blooms Taxonomy level 4 because the concept map shows the connectivity of positive and negative numbers to integers. The map continues to give examples of positive and negative numbers correctly.

The concept map provided by Carl shows the word underline, identified as linked to the concept of integers. The number lines given are horizontal and vertical. The horizontal number line has both positive, negative numbers and zero is placed in the middle. Considering the use of the number line as a model the concept map shows that Carl remembers integers, positions positive and negative numbers in the correct position in the correct order. The altitude, height above sea level was clearly demonstrated in the vertical number line. The number line concept model can be placed in the Blooms Taxonomy level 4.

The concept map provided by Carl shows operations such as minus, ordering of integers ascending and descending. The concept mapping indicates the ability to add integers, the ability to subtract integers. The concept map shows that 7 is smaller than 8 and 8 is greater than 7. This demonstrates a clear understanding of the comparisons of integers blooms taxonomy level 4.

The concept map states that zero is in the middle of the number line when working with integers. This is well explained for an intermediate phase grade level. The concept map gets blooms taxonomy level 5 and this is too advanced for the grade level.

Carl's concept mapping shows that counting back is linked to integers. The concept map shows counting back in ones as it shows 4, 3, 2 and 1. Considering the blooms taxonomy Carl is given blooms taxonomy level 4.

Results

- Learners in the intermediate phase are able to use concept maps as tools to show what has been learnt a topic
- Learners in the intermediate phase are able to use concept maps as tools to show what has not been understood a topic.
- Concept mapping can be used as an instructional and an assessment tool in the intermediate phase classroom
- Concept maps lack some convincing detail as the learners' work is only at the level of the children before being taught

Advantages and disadvantages of using concept mapping

Advantages: Concept mapping is a visual organization tool: it accords

the cognitive representation theory of cognitive psychology the knowledge:

- Concept mapping organizes concepts which promote meaningful learning for the learners see all three Erry, Why and Carl mapping concepts
- Concept mapping supports overall learning styles and enhance understanding of the concepts
- Concept learning help learner reflection in all information learnt in all subjects
- Concept mapping promote dialogue in all subjects [3]

Disadvantages: The presentation of concepts tends to have limited information because the meta-cognition of concept mapping is limited in the phase. The learners have challenges in presenting their inner thinking mode. The concept maps could not obtain Blooms Taxonomy level 6.

The evaluations used in this article are subjective rather than objective. The criteria used assessing concept maps may lack criteria. It is a multiple assessment method. The level of taxonomy was not affected by the spellings but by concept explanation see Why and Carl's concept mapping.

The use of concept mapping is time consuming both for the learner and the facilitator. The learners need a lot of time and concentration in order to come up with a meaningful concept map.

The concept map may sometimes fail to provide all the explanation for the concept itself although it has the advantage of connecting what the learner already know, the concept map does not provide new learning material.

Conclusion

The concept map provides or presents the knowledge in a whole picture. This picture is what is already known does not provide room for growth. The mapping concept helps learners in the intermediate phase to realize that understanding is more important than memorizing and share each person's different ideas. The teaching method of using concept mapping has more advantages than disadvantages. Concept mapping is regarded as a powerful tool for teaching and assessing and in the case of the three intermediate learners; it helped them to organize the topic integers in a totally different way that the learners understood. Concept mapping is a permanently regarded as a powerful tool for teaching and learning all subjects at any level.

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