CONCEPT MAPPING IN GEOGRAPHY TEACHING: FOSTERING ACTIVE LEARNING

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Abstract: Concept mapping is a powerful tool to foster meaningful learning, it was created by Joseph Novak and his colleagues. Nowadays the strategy of concept mapping suffers big evolution in theory after seven international conferences (CMC). This active learning combine with other strategy and technology (CmapTools) can change the classroom and provoke big impact in the students. In this paper, the use of active learning with concept mapping combined with peer review allows students to be protagonists of their own learning. The results show that the students were more involved and the classroom has changed completely facilitating meaningful learning.

Keywords: Concept mapping; Active learning; CmapTools

Introduction

Education and society as a whole have changed in recent decades. The educational process, the students, knowledge and professional skills are different nowadays, so schools need to be updated to keep up with these changes. Every day, new technology is launched and schools have to deal with it, opening up opportunities for students to develop critical thinking skills in a meaningful learning environment. In order to do that, students need to understand that their previous knowledge and experiences are important and they are the tools to scaffold new knowledge.

With this in mind, active pedagogies have much to offer to the students and active learning is one of the best ways to achieve meaningful learning. In this paper, it is advocated that concept mapping is a valuable strategy to foster meaningful learning, supported by Cmaptools. Applied in geography lessons, this tool can be combined with other strategies, like peer review, to allow the students to be at the centre of the learning process.

Conceptual content in lessons is supposed to be related to daily life, for students to identify the applicability of what they learn. Geography is one of the school subjects that is able to explain a wide range of daily events, such as the rain that causes floods in cities, the daily violence that is sometimes in the student's neighbourhood, the economic crisis that affects the student's family. In this sense, students' knowledge can be taken into account in

lessons to establish the relationship between concepts learned in school and what they experience outside it.

The aim of this paper is to discuss the role of concept mapping, peer review and the Cmaptools in fostering active learning in geography lessons. Two active learning situations were exemplified, challenging the traditional teacher-centred approach usually used in geography teaching in Brazil.

The study involved the participation of thirty-eight high school students and their teacher, in a piece of action research associated with other forms of collective action oriented toward transformation goals or problem-solving.

Concept Maps and active learning: a way of achieving meaningful learning

Active learning happens when students participate in the process and do not passively listen to what the teacher or tutor has to say about specific content (Weltman, 2007). Students get involved in the process, maybe at different levels of participation (Bonwell and Elison, 1991) and do things and think about what they are doing. 'Participation' means reading, discussing and engaging in problem-solving (Bloom, 1956). Students should also be engaging in other higher-order thinking tasks such as analysis, synthesis and evaluation of what they are studying. As the construction of concept maps demands active participation and covers all the elements explained, the construction of concept maps can be considered active learning.

According to Ausubel (2000), meaningful learning happens when the learner chooses to relate new information to the knowledge he/she already has. This is a process that depends on the conceptual richness of the new material to be learned and the quantity and quality of the organisation of the relevant knowledge held by the learner. However, it is possible for learners to memorise new information without making these meaningful connections. This process is called rote learning.

Novak (2010) argues that meaningful learning has three requirements: (a) Relevant prior knowledge – the learner must know some information that relates to the new information to be learned; (b) Meaningful material – the knowledge to be learned must be relevant to other knowledge and must contain significant concepts and propositions; (c) The learner must choose to learn meaningfully – the learner must consciously and deliberately choose to relate new knowledge to relevant knowledge they already know.

According to Novak and Cañas (2008), concept maps are graphical tools for organising and representing knowledge. They include concepts, usually enclosed in circles or

boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts.

One of the most important functions that concept maps have is to help a group to register, map and come to a consensus on their collective knowledge regarding a question or set of questions relevant to the group. Those who have used concept maps in lessons have noticed that some students find it difficult to draw up and use them, at least in the beginning (Cañas, Novak & Reiska, 2015). This is explained by years of rote learning that happens in schools. Many teachers who orient students towards memorising facts only are not worried about offering opportunities for learners to develop critical thinking and establish connections between content learned in schools and reality. Learners are guided just to know one right answer for specific questions and they do not need to know why. Concept mapping demands that students establish different connections among elements in a specific piece of content and that teachers are aware of the types and quantity of connections that should be made in the topic taught. As a consequence, it is not easy for a student to quickly switch years of rote learning to meaningful learning.

Cañas et al. (2015) claimed that a meaningful concept map is supposed to have a specific structure and follow some rules. They developed some criteria to assess concept maps (see fig. 1).

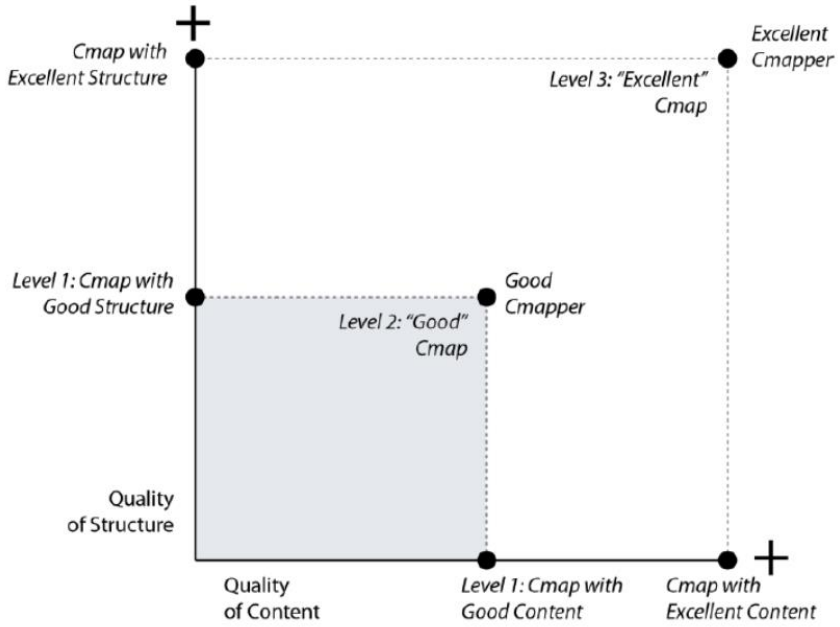

Fig. 1 - A good concept Cmapper creates concept maps that have a good graphical structure and good content. Suggested by Canãs et al. (2015).

The criteria presented for assessing the quality of structure and content of a concept map would suggest that a concept map that satisfies these criteria could be a "good" concept map.

Cañas et al., (2015) classified concept maps at levels 1, 2 and 3 according to their content and structure quality (See Table 2). This study does not focus on analysing level 3 concept maps, as the participants in this research were not professional Cmappers.

Quality Level	**Structural Quality**	**Content Quality**	**Concept Map Quality**
1 Poor	√	-	-
	-	√	-
2 Good	√	√	-
3 Excellent	√	√	√

Table 1. Classification of concept maps depending on the quality of the structure, content and the quality of the concept map. Suggested by Canãs et al. (2015).

The use of Concept Maps in Geography lessons

There are few studies on concept maps focusing on its use in teaching geography. With the first Concept Mapping Conference (CMC) in 2004, there was an expansion of the strategy of concept mapping for other disciplines of knowledge. Nowadays, studies are found on its use in teaching history, geography and languages.

Akbaş and Gençtürk (2011) developed a study in which they used concept maps to identify misconceptions high school students had regarding the topic of "Air Pressure". A control group was taught with a teacher-centred approach in comparison to a student-centred approach in which concept maps were used as a tool to deal with misconceptions. Two separate tests were used for data collecting; a success test, to define students' knowledge level about concepts and discover their misconceptions, and a concept test, to define the level of students' misconceptions before and after the study, were employed as a pre-test and post-test involving multiple choice questions. In the pre-test, no difference was observed in the results of the two groups. In the post-test, the research results showed that educational methods based on the use of concept change texts combined with concept mapping are more efficient than traditional teaching methods.

Akbaş and Gençtürk (2011) concluded that concept maps are helpful to identify learners' misconceptions that happen during the learning process. By diagnosing their misconceptions, it was possible to clarify specific doubts before introducing a new topic. They argued that without making clear these misconceptions, scientific knowledge is very difficult to be learned as students take for granted that what they believe are the "correct" facts and concepts.

Okafor (2016) studied Nigerian high school students from different groups. A sample of 225 students were defined in an attempt to understand the problems that affected the performance of students in national geography exams. According to the author, two points were raised: geography has a very wide content and teachers have used ineffective methodologies in lessons. The researcher developed a quasi-experimental study of a non-equivalent control group. The author argued that it was not possible to have complete randomisation of the participants. Intact classes were used. The study was quasi-experimental because the researcher manipulated the independent variables of the study, which were concept mapping and outlined note-taking patterns, and observed their effects on achievement. The intact classes randomly assigned to experimental and control groups were used. Three groups were created to test the author's hypothesis. The first was experimental group one, which was taught with concept mapping notes. The second was experimental group two, which was taught with outline notes. The third was the control group and it was taught with conventional notes. At the end of the lessons, students were assessed through a national TOGAR (Test of Geography Achievement and Retention) exam. The results showed that the students of experimental group one, who learned geography with the support of the concept maps, obtained better results than the other two groups.

Wehry, Monroe-Ossi, England & Fountain (2010) proposed assessing the knowledge of middle school students of human geography who participated in an "after school" programme. The purpose of the programme was to motivate students in the subject. There were 43 participants, composed of 29 girls and 14 boys. They used the select-and-fill-in (SAFI) approach. Researchers developed concept maps and used the key concepts studied in middle school students. They presented concept maps by removing some concepts and phrases of connection, for students to fill in properly. The results showed that students had got confused due to the teaching approach and methodology in the lesson. The authors concluded that concept maps were important for evaluating the acquisition of knowledge of human geography. However, it is still necessary for the curriculum to be reviewed because it is still

not clear for the students, despite the fact that most students achieved good results by completing concept maps of the three years of teaching they surveyed.

Campelo and Piconez (2016) investigated the extent to which concept maps can foster meaningful learning in high school students. Forty geography students participated in the study. The students made a concept map during the second stage of the research and these maps were compared with other semi-structured ones made during the fourth stage. For the analysis of these concept maps, the methodology of Hay (2007) was used to understand the type of learning that occurred with the students. Nowadays, student testing with the purpose of memorising content - mechanical learning - continues to prevail in schools in Brazil. Using concept maps in K-12 can contribute to a change in the learning of our students. The results showed that students need more time to practice the concept mapping technique, despite the fact that progress was observed during the making process of concept mapping.

Method

Participants

Thirty-eight high school students from the Federal Institute of São Paulo participated in this study. The study was conducted during geography lessons for the period of six months in 2016 and they were randomly split into pairs. The only requirement was that partners had not worked together in previous groups.

Procedures

The research design chosen to be used was classroom action research (Elliot, 1991; Stenhouse, 1975) because the purpose of adopting this approach was for teachers as researchers to improve their practice and, as a consequence, enhance the learning process. As McNiff (2002) argues, "it is a practical way of looking at your practice in order to check whether it is as you feel it should be" (p. 15). The purpose was to reflect on their own practice in order to "bring about practical improvement, innovation, change or development of social practice, and the practitioners' better understanding of their practice" (Zuber-Skerritt, 1996, p. 83).

The process of adopting action research involves four steps: planning, acting, observing and reflecting (Kemmis & McTaggart, 1988). By using action research, it was possible for the researchers to plan interventions in lessons which the aim was improvement in the teaching and learning process as both students and teachers/researchers were equally part of the process (Waterman et al, 2001).

The steps in which action research was used in this study were three. First, students learned concept mapping techniques and how to work collaboratively to solve a given task. The students each created a concept map 1 (MC1) on the topic of geology, using paper and pen and with the support of a textbook, video and report on geology. All MC1 maps were analysed in detail by the teacher and returned to the students with feedback. The teacher also undertook collaborative feedback with the 38 students, explaining the misconceptions related to the studied content and on the techniques of concept mapping. In another step, students were split into pairs and, using feedback from MC1, they worked collaboratively and created concept map 2 (MC2) using CmapTools, which would be an improved version of MC1. Two pairs had their interactions recorded during the elaboration of MC2 to be analysed. After finishing MC2, peer review was done and each pair provided feedback on two MC2s. They also filled out a form with suggestions for improvement of the MC2. Finally, students presented their final concept map (MC3) to the class and explained whether the suggestions given were accepted or not and why.

Results

The first concept map elaborated by the students showed some errors in the technique of concept mapping. As it was the first time they had used this strategy, these errors were expected. However, as they were studying the concept of geology, they were supposed to know the concept in order to construct a good concept map. MC1 was constructed after they had been studying this content. A focal question was used to select a specific knowledge domain for the first concept map. The question was, “What is the relationship between tectonic plates and earthquakes? Fig. 2 shows the MC1 developed by Lucas. The content of the MC1 is good; the student was able to adequately answer the focal question.

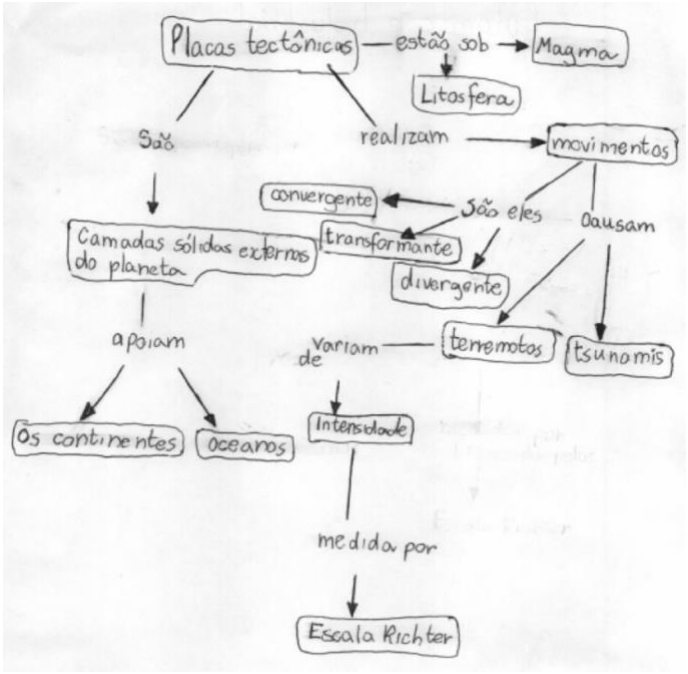

Fig.2 - MC1 created by Lucas (in Portuguese).

The structure is good; the more general concept is at the top of the MC and the more specific concepts at the bottom; in addition, the student has used the arrows and the connecting terms appropriately.

Although this example can be classified as a good CMap, the student was not able to establish cross-links between the concepts in his first MC1. More training is needed in the technique of concept mapping to exemplify how well the student knows the subject.

Fig. 3 exemplifies another MC1, by Patricia. Both the structure and content are poor. The student did not answer the focal question properly, using few of the concepts studied. Regarding the structure, the arrows indicating the direction of the reading of the concept map were missing. Besides this, the student was not able to make cross-links between the concepts. It should be remembered that students were beginners in the technique of concept mapping and would not be developing a satisfactory concept map at first. The intervention of the teacher was needed in order to provide individual and collective feedback to solve problems related to the content and to the structure of the concept map.

Although training in the concept mapping technique is fundamental, it is worth mentioning that some students can develop this ability better, while other students produce texts with greater ease. We can classify MC1 as poor.

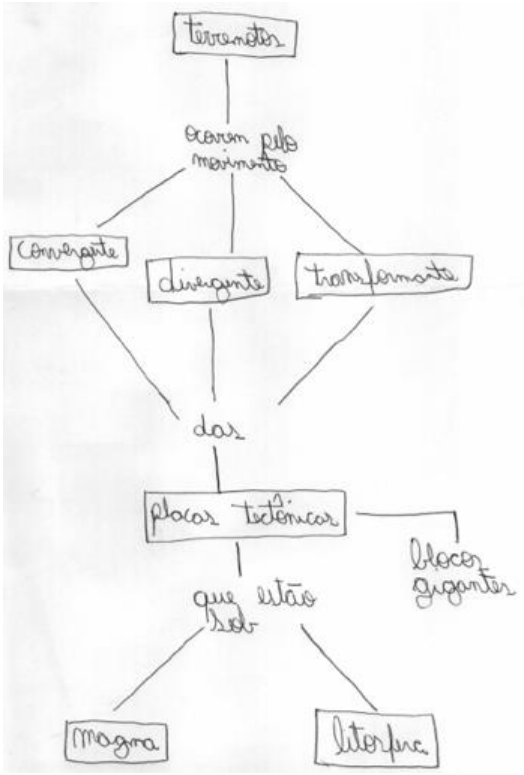

Fig.3 - MC1 created by Patricia (in Portuguese).

Fig. 4 is the collaborative work done by students Lucas and Patricia using CmapTools. Both students elaborated the final version of the concept map after discussing and working collaboratively based on their recordings. They also received feedback from two other pairs and discussed whether or not they would accept the suggestions proposed by the other pairs. Students were able to analyse their production in detail and recognised that many suggestions were coherent and would contribute to the quality of the concept maps. Because of this, most students accepted the suggestions given.

A more detailed analysis of the double-sided concept maps showed that both content and clutter have improved greatly compared to individual maps. There are still corrections to be made that have been shown in the teacher´s feedback to the pair.

Students numbered the linking terms to facilitate the reading of the concept map, but they were not able to create several cross-links between the concepts, showing that they need to improve their knowledge about the content studied. It was possible to classify MC1 could be classified as good. According to the concept mapping experts, more training in the technique is necessary to reach the level of "excellent".

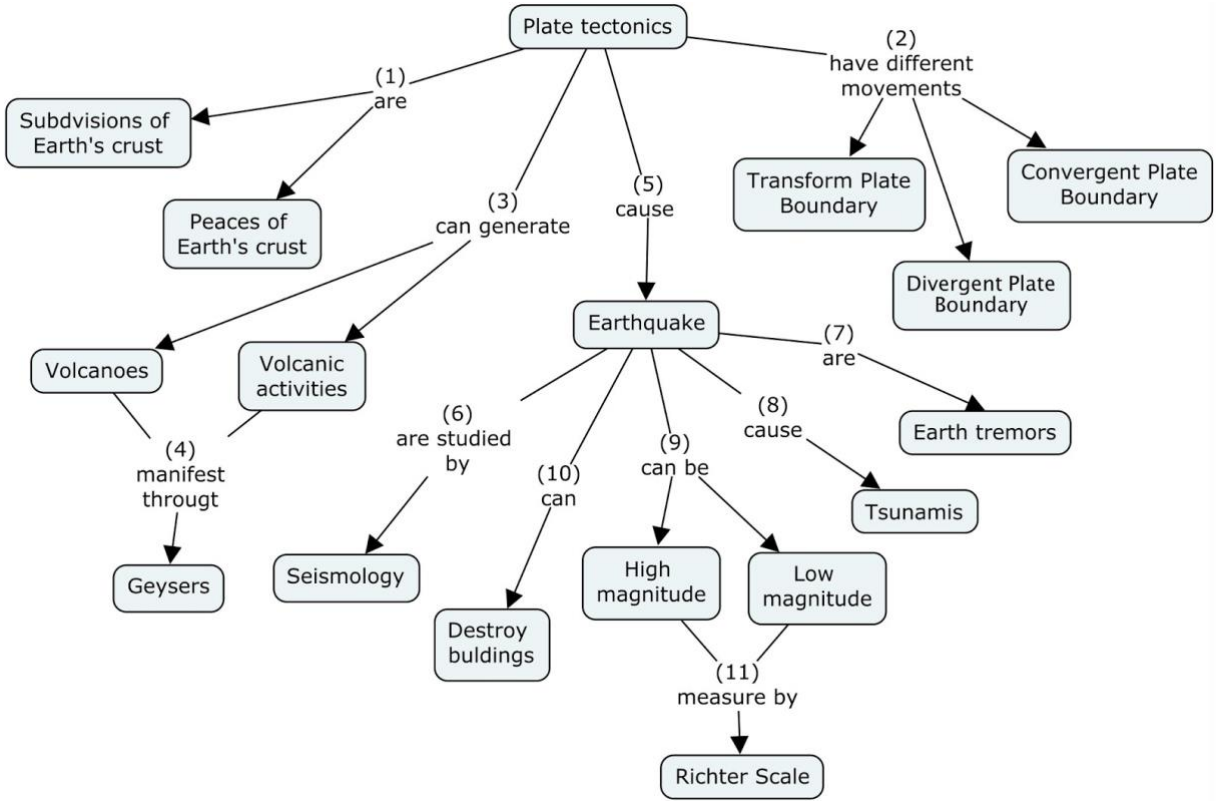

Fig.4 - MC2 created by Lucas and Patricia.

Discussion and Conclusion

The concept mapping task can be used in educational practice in several ways. While it may not be strong enough to change students' misconceptions, as an introductory task, concept mapping can encourage them to verbalise their concepts, to discuss them, and to elicit the need to answer questions and test assumptions. A concept map is a good instrument for teachers to quickly diagnose students' use of misconceptions. The collaborative concept map task can also assist students in taking more responsibility for their own learning during the course.

In this research we found some difficulties. First, the students were used to rote learning: just memorising data. It made the process of elaborating concept maps challenging, although with more training, students would improve their skills and meaningful learning could happen. Second, students did not master the basic concepts of geography. Because of this, extra classes were needed to solve their problems. Third, the students also had basic language problems, which impacted the construction of clear propositions that were the determinants of a good and cohesive concept map.

What teachers and students need to keep in mind is that in order for concept maps be used as a knowledge assessment tool, students should master the techniques of building

concept maps. If students have not mastered the techniques and understood the function and properties of concept maps, their production might present problems of structure and meaning, which might not represent what they really know about the content. Teachers must dedicate some time in their lessons to enabling students to learn how to build concept maps, otherwise what they construct will provide a fake example of their knowledge.

This active learning with concept maps was developed in the context of a high school geography classroom. The results show that the students were more involved and the classroom changed completely, facilitating meaningful learning in the content of geography.

Finally, the concept mapping strategy provides a better understanding of what can and should be evaluated in student learning; it enables the teacher to visualise the existence or not of previous concepts of geography considered as prerequisites for the meaningful learning of new concepts; it makes students protagonists of their own learning and of the innovative process of evaluation; it requires several versions to graphically show the modifiability of structures of thought that reveal how students construct knowledge.

For future research, it will be important to understand better what the students' misconceptions are about the topic that will be taught. Moreover, it will be easier to prepare the material for the students and help them to elicit their knowledge through concept maps.

References

Akbaş, Y., & Gençtürk, E. (2011) The Effect of Conceptual Change Approach to Eliminate 9th Grade High School Students' Misconceptions about Air Pressure. *Educational Science: Theory & Practice*. 11[4, 2217-2222.

Ausubel, D. P. (2000). *The acquisition and retention of knowledge*: A cognitive view. Boston, MA. Kluwer.

Bloom, B. (1956). *Taxonomy of Educational Objectives*: The Classification of Educational Goals. New York: McKay.

Bonwell, C. & Eison, J. (1991). Active Learning: Creating Excitement in the Classroom. *Information Analyses - ERIC Clearinghouse Products* Vol 71.

Campelo, L. F., & Piconez, S. C. B. (2016). Concept Mapping in High School: An Experience on Teaching Geography to Measure Deep, Surface and Non-Learning Outcomes. In: CAÑAS, A.; REISKA, P.; NOVAK, J. (Eds.) *Innovating with Concept Mapping. Springer – Communications in Computer and Information Science (CCIS)*, 635, 29-39.

Cañas, A. J., Novak, J. D., & Reiska. P. (2015). How good is my concept map? Am I a good Cmapper? Knowledge Management & E-learning, 7(1), 6-19.

Weltman, D. (2007). *A Comparison of Traditional and Active Learning Methods*: An Empirical Investigation Utilizing a Linear Mixed Model, PhD Thesis, The University of Texas at Arlington.

Elliot, J. (1991). *Action Research for Educational Change*. Buckingham: Open University Press.

Hay, D. B. (2007). Using concept maps to measure deep, surface and non-learning outcomes. *Studies in Higher Education*. Vol. 32, n.1, 39-57.

Kemmis, S. & McTaggart, R. (1988). *The Action Research Planner.* Victoria: Deakin University Press.

Novak, J. D., & Cañas (2008). *The Theory Underlying Concept Maps and How to Construct and Use Them*. Technical Report IHMC. Available at: http://cmap.ihmc.us.docs/pdf/TheoryUnderlyingConcepMaps.pdf

Novak, J. D. (2010). *Learning, Creating and Using Knowledge – Concept Maps as Facilitative Tools in Schools and Corporations*. New York, NY: Taylor and Francis.

Okafor, G. A. (2016). Effect of Concept Mapping and Outline Note-Taking Pattern in Students Academic Achievement in Geography in Secondary Schools in Enugu South Lga of Enugu State. *Journal of Education and Practice.* Vol.7, No.5, 53-60.

Stenhouse, L. (1975). *An Introduction to Curriculum Research and Development.* London: Heinemann.

Tripp, D. (2005). Pesquisa-Ação: uma introdução metodológica. *Educação e Pesquisa*, São Paulo, v. 31, n. 3, 443-466.

Waterman, H. Tillen, D., Dickson, R. & de Koning, K. (2001). Action Research: a systematic review and guidance for assessment. *Health Technology Assessment.* Vol. 5, No. 23.

Wehry, S., Monroe-Ossi, H., England, R., & Fountain, C. (2010). The Development of a Select-and-fill-in Concept Map Assessment of Human Geography Knowledge. In: SÁNCHEZ, J, CAÑAS, A. J., NOVAK, J. D. (Eds.). Concept Maps: Making Learning Meaningful. *Proceedings of the Fourth Int. Conference on Concept Mapping*. Vol. 1. Viña del Mar, Chile, 385-392.