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Interactive Learning Based on Concept Maps in Learning Algebraic Structure

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***Abstract*—This article presents the use of concept maps in designing interactive learning in the learning of algebraic structures, that is an alternative that can be used by students as a first step in resolving the problems of proof in the course of algebraic structure. The concept mapping in this research refers to the anchoring of new ideas or concepts in previously acquired knowledge that is used to state the meaningful relationship between what is known in the problems and the concept that will be used to prove the problems. This research was conducted at the Postgraduate of Universitas Negeri Makassar (UNM), in the academic year 2017/2018 of master's degree in mathematics. The results indicate that: (1) Interactive concept mapping in learning algebraic structure can help students in constructing relationships between concepts in solving proof problems; (2) The learning activities of students in terms of educational interaction in lectures can be optimized, as most of students (86.3%) from 22 student participants reported have a good skilled at determining what will be found or shown from the proof problems; (3) However, the total postgraduate students in completing the proof problems correctly in this study still have reached 68.2%. Consequently, the implementation of interactive learning based on concept maps needs to be developed in the learning of algebraic structures.**

Keywords—interactive learning, concept maps, proof

I. INTRODUCTION

Intermediate algebraic structures is a compulsory lesson in curricula at the Postgraduate in mathematics education of Universitas Negeri Makassar (UNM). This lesson aims to give the students an understanding of algebraic structures so they can implement it to solve the fundamental issue in algebra as well as they have logical thinking and mathematical reasoning to solve problems. Therefore, the course is essential for students to improve their ability in making deductive, logic and systematic decisions.

Intermediate algebraic structures are the lesson which relies on the tough deductive axiomatic. Birkhoff [1] pointed out that "the most striking characteristics of modern algebra is a deduction of theoretical properties of such formal systems as groups, ring, fields, and vector spaces." Thus, intermediate algebraic structures included definitions and theorems, so that the students in learning the course are required to be able to prove the theorems, and can utilize existing definitions and theorems in solving problems that are generally in the form of proof. As Birkhoff [1], Fraleigh [2]; Herstein [3]; Raisinghania [4], Pinter [5] and Suradi [6] book's, in general, the questions are given are a matter of proof.

According to experiences of researcher's teaching practice in postgraduate class at Department of mathematics education in UNM for the last two years, the students still met the difficulties in reaching the aim of the lesson especially in resolving the problems. The participants were not able to interconnect the concepts. As a consequence, it was difficult to be interlinked between concepts in previously acquired knowledge and the concepts that will be used to prove the problems. It is noted that student interaction in the class couldn't well work since they are unable to determine what will be found or shown from the proof algebra problems. In order to solve the difficulties of learning intermediate algebraic structures, therefore, there is a need to design interactive learning, in particular, an interactive concept mapping.

II. INTERACTIVE LEARNING

Through the interaction in the classroom, students have opportunities to share their ideas like the social community so that they will have better-understanding mathematics by construction and negotiation approaches [7]. Likewise, [8] pointed out that mathematics classroom as a place for the learners (student and teacher) to develop interactively social environment. By doing so, the primary objective is to improve the learning process and to open new insights of students in solving a mathematical problem by reflective and responsive approaches.

Jones and Thornton [9] argued that learning could engage in various internal development processes, which is able to be implemented once a student is interacting with communities in environment and peers. A student can engage the lecturer or peers either whose capacity to solve the problem. Some peers may provide support as a scaffolding. Therefore, the student can do well-internalization and help to maximize their Zone of Proximal Development (ZPD) to improve their knowledge in a higher understanding.

Vygotsky believed that all psychological process involved in social interaction is such a manifestation among individual's interaction. Furthermore, Wilson, Teslow, and Taylor [10] stated that students' experience in problem-solving activities with peers enables internalization of concept independently. A fundamental idea of Vygotsky in Jones & Thornton [9] is social interaction and ZPD recognition. Therefore, once students act interaction with such learning equipment and utilizing a conceptual map, their ZPD is automatically utilized to be a higher level of insight.

De Vries & Kohlberg [11] pointed out that one of the fundamental characteristics of constructivism of Piaget to support teaching mathematics is that student must have opportunity to reinvent (construct) mathematical relation itself, not merely just from their lecturer.

Constructivism can be viewed in terms of cognitive and methodology. In the cognitive view, all knowledge is constructed, and the results be a part of the cognitive structure as cognitive development. In methodology view, human as a subject to know something and human behavior is the main target, as well as human, has a high capacity to organize the knowledge. Wilson, Teslow & Taylor [10] argued that the framework of constructivism consists of (a) knowledge constructed from experiences, (b) learning produces personal interpretation of knowledge, (c) learning is an active process developed by experiences and (d) the learning is collaborative process that is negotiated from double perspectives.

Based on the description above, it can be stated that optimum interaction is needed in learning. Therefore the need for interactive learning is unavoidable which can facilitate student to student or student to lecturer interactions. The role of lecturers in interactive learning is laid as motivator and facilitator to optimize the interactions.

III. METHOD AND CONCEPT MAP IN LEARNING ALGEBRAIC STRUCTURE

The topics in the course of Algebraic Structure are based on the axioms that make up a system. For example, suppose G is a non-empty set with an operation * defined on it. $\langle G,*\rangle$ is said to be a group, if the operation '*' satisfies the following axioms (called group axioms):

(1) $(\forall a, b\in G)\ a*b\in G$ (closure)

(2) $(\forall a, b, c\in G)\ a*(b*c) = (a*b)*c$ (associativity)

(3) $(\exists e\in G)(\forall a\in G)\ a*e = e*a = a$ (identity)

(4) $(\forall a\in G)(\exists a^{-1}\in G)\ a*a^{-1} = a^{-1}*a = e$ (invertibility)

Furthermore (1), (2), (3), and (4) are called group axioms. According to Soedjadi (1999/2000) "axiom" is a "baseline statement" in the mathematical structure needed to avoid spinning in proof. While the term system is defined as "a set of elements or elements that are related to each other and in which there is a hierarchical relationship." A collection of axioms can be a system if it meets (1) consistently: the axioms are not contradictory; (2) independent: one axiom cannot be derived from other axioms; and (3) complete: statements derived from the system can be proven to be true and wrong. Therefore, a collection of all four axioms in the group mentioned above forms a system of axioms, called the group axiom system.

Regarding the description above, to solve proof problems in the algebraic structure, it takes a deep understanding of axioms, defined concepts, and various theorems. For this reason, the use of concept maps in solving the problems of proof in algebraic structures is needed.

The proof is one of the problems in mathematics. According to Polya [12], problems in mathematics are grouped into two types, namely problems to find any problems to prove. The purpose of proof is to show that a statement is true or false, not both. We must answer the question "is it right or wrong?" (Certainly in the scope of dichotomous logic).

The process of mathematical proof can use definitions, theorems or statements that have been proven before. Therefore, in establishing confidence in the proof results that have been obtained, every step used in the verification must always be questioned "why" and "what is the reason." Likewise, in proving the problem in the algebraic structure, every step which has taken must always be questioned about its validity. For this reason, mastering the concept is the main requirement in solving the problem of proof.

Some of the mistakes that are often experienced by students in learning algebraic structures are caused by "misconceptions." One of the causes of these errors is the lack of understanding of students about the problem; they still have difficulties in identifying "what is known in the problem" and "what will prove." Even if these two things can be written correctly, the difficulty that arises is "connecting" what is known and other qualities that fulfill what will be shown in solving the problem. To state the meaningful relationship between concepts, students can use concept maps. Novak & Gowin [13] suggests that concept maps are a tool (in the form of a scheme) which is used to express meaningful relationships between concepts in the form of propositions.

Concept maps serve to clarify the main ideas for lecturers and students who are focusing on specific lesson assignments. In addition, it can also show visually various ways that can be taken in linking the notions of concepts in the problem. Thus, the concept map can be used in meaningful learning, to link new concepts or new information with concepts that already exist in the cognitive structure of students. By making concept maps in solving problems, it can also increase students' understanding of the concepts and the relationship with other concepts.

IV. RESULT

Based on the limited trials that were conducted at the Postgraduate of Universitas Negeri Makassar (UNM), in the academic year 2017/2018 of master's degree in mathematics education. An interactive concept mapping design is obtained with the following steps:

a. Apperception: the lecturer reminds the material that has been taught before; by doing so, the lecturer asks students randomly. The students' responses were responded by other students, and finally, the lecturer concluded the prerequisite material about the material to be taught at the meeting.

b. Learning Objectives: the lecturer conveys the learning objectives to be achieved at the meeting, and delivers material briefly about the concepts in the textbook related to the material to be taught.

c. Working in groups: lecturers involves students working in groups (group members are determined by lecturers, endeavored by each heterogeneous group in terms of students' academic abilities) to make concept maps of material in the textbook for the learning activity. One example of a concept map formulated in a discussion of groups, subgroups and normal subgroups (Fig. 1).

d. Scheme of proof with Concept Map: the lecturers challenge students to make concept maps in solving the proof problem (Fig. 2).

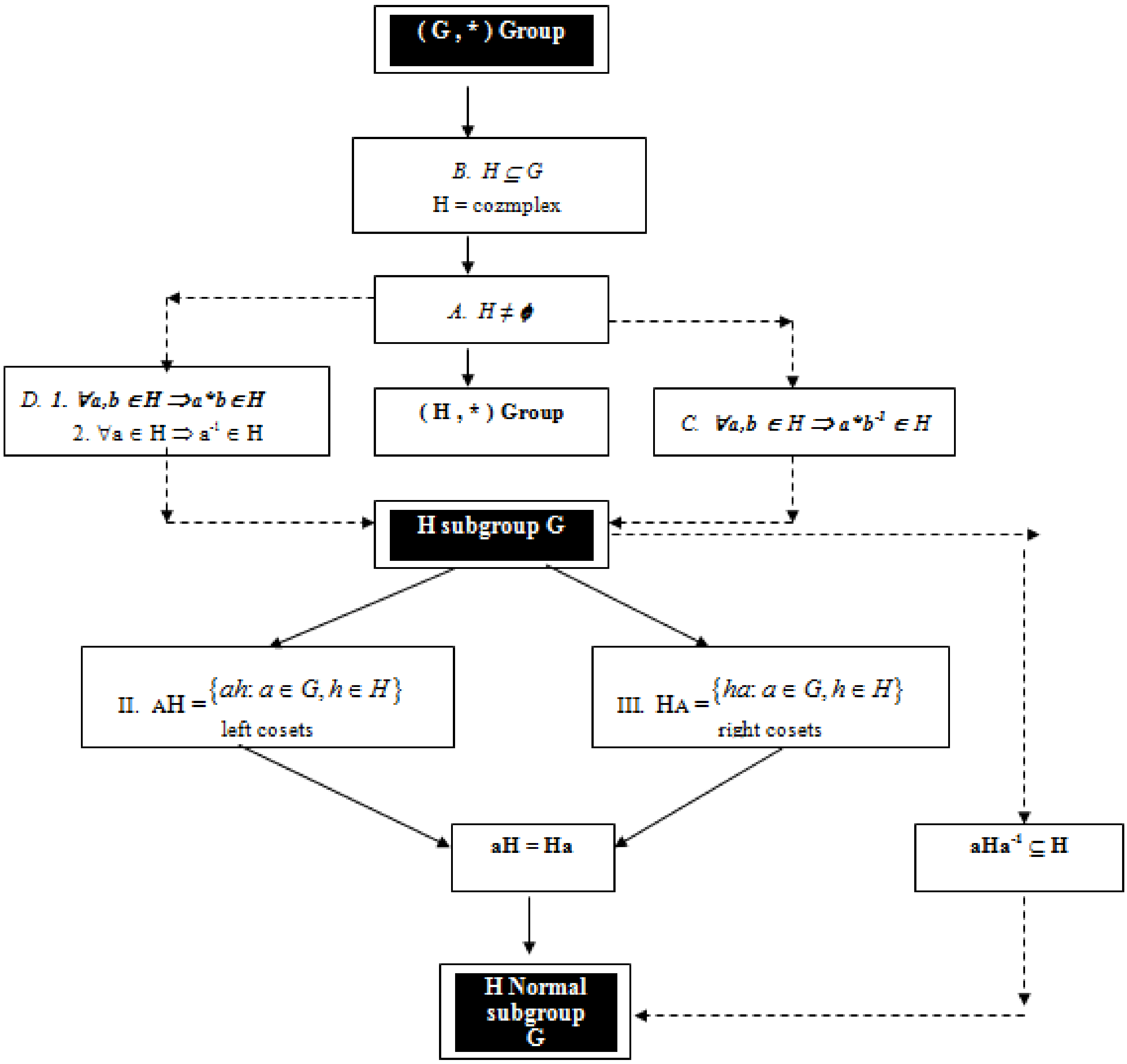

Fig. 1. Concept map of Group, Subgroup, dan Normal Subgroup

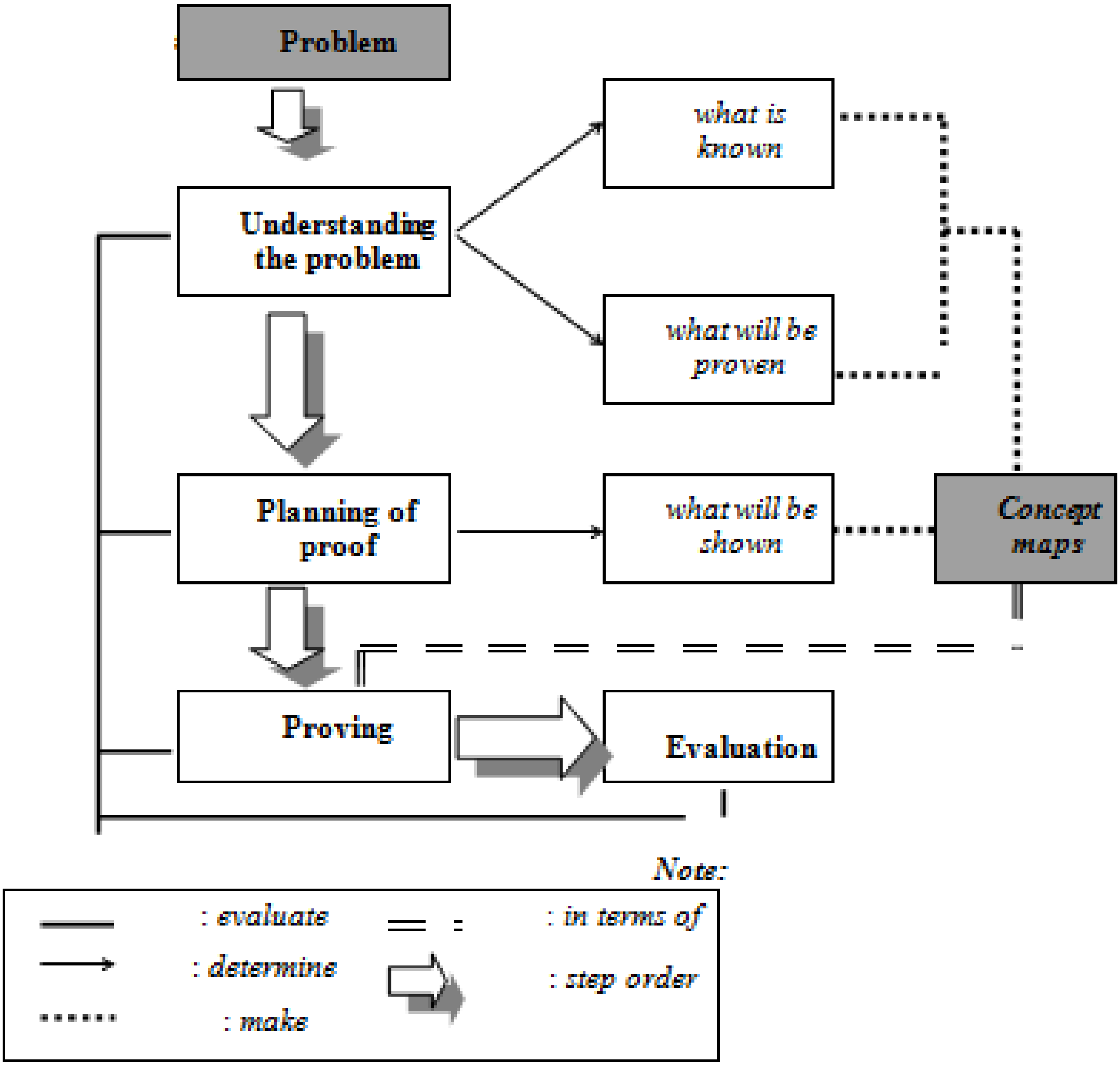

Fig. 2. Scheme of Proof by Utilizing the Concept Map

Based on the scheme above, than in solving the proof problems can be done by the following steps.

1. Understanding the problem (what's the problem?): Understanding what is known, and understanding what will be proven.
2. Planning proof (what will be shown?): finding a relation of what is known and what will be proven, choose theorems, or concepts that can be used in the proof.
3. Proving: every step is checked for validity (giving a reason for each step).
4. Re-checking (evaluation): has the result matched ? what is known in the problem have been utilized? and is the theorem or concept used to fulfill the conditions?

The results of interactive learning based on concept maps on 22 students in the mathematics education master program, with six meetings in learning group topic, showed that: (1) Interactive concept mapping in learning algebraic structure could help students in constructing relationships between concepts in solving proof problems; (2) The learning activities of students in terms of educational interaction in lectures can be optimized, as most of students (86.3%) from 22 student participants reported have a good skilled at determining what will be found or shown from the proof problems; (3) However, the total postgraduate students in completing the proof problems correctly in this study still have reached 68.2%. Consequently, the implementation of interactive learning based on concept maps needs to be developed in the learning of algebraic structures.

V. Conclusion

Based on the results of this study, it can be concluded that utilizing concept maps is needed by students as a tool to plan proofs. With a concept map, students can interact to see the linkages of concepts and their application in solving problems visually. Thus, their learning process in proof will be more meaningful. For this reason, it is necessary to develop interactive learning models based on concept maps in the learning of algebraic structures.

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