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BUILDING PROSPECTIVE SCHOOL MATHEMATICS UNDERSTANDING OF PROSPECTIVE TEACHERS THROUGH ALGEBRA ABSTRACT COURSE

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Abstract
Student teachers are prepared to become mathematics teachers where they will teach mathematics at school, but students need to be equipped with pure mathematics such as Abstract Algebra, which is the foundation of mathematics, not only school mathematics knowledge, so students can learn to form a solid understanding of mathematics. The structure of mathematics, including abstract algebra, is generally consistent, logical, systematic and can make everyone who learns it requires complex abilities, so that it often makes students who study it get difficult and they think the material being studied is not needed if they will teach school mathematics later. The purpose of this study was to find out how the development of students' understanding as prospective teachers of the connection between Abstract Algebra courses and mathematics taught in schools through every essential question and project in the form of abstract algebra applications in everyday life, school mathematics and other fields after learning abstract algebra. The method used in this study is a quantitative method with the design of One group Pretest-Postest using the non-parametric Wilcoxon test. Collecting data through questionnaires, and student interviews. The results showed that through a series of abstract algebra lectures students realized that abstract algebra courses were the basis for teaching school mathematics because the use of abstract algebra material was closely related to everyday life, school mathematics and other fields .

Keywords *: Abstract Algebra; Connections; SchoolMath*

INTRODUCTION

Mathematics is divided into two major parts, namely pure mathematics and applied mathematics. Pure mathematics is more focused on increasing knowledge of a mathematical subject than its application, whereas application of mathematics is concerned with the use of pure mathematics in various fields. Often the theory developed in pure mathematics will find application later, and the two parts are interrelated (Yadav, 2017). Mathematics itself is built by several fields including algebra, number theory, mathematical logic, computational theory and so on. While the application of mathematics in various fields such as mathematical chemistry, mathematical physics, economics, statistics, financial mathematics, biomatics and so on. So it is possible that the material in pure higher education mathematics is difficult to apply directly in other fields of science or everyday life. Apart from that mathematics also uses imagination, intuition and reasoning to find new ideas and to solve confusing problems (Khan 2015). In abstract algebra the formation of a new algebraic structure is largely determined by the definition of operations on that set. Definitions are an important part of developing algebraic structures (Clarisa, 2021). Abstract Algebra courses require the ability to understand and prove various theorems and are different from the competencies developed while studying at school, namely the ability to calculate and use formulas. The difference in competencies that are expected and possessed by students is what becomes a difficulty for students in learning abstract algebra. At the school level, students rarely develop proof skills, more math skills or formula skills. Under these conditions, it is often found that students consider pure mathematics material such as abstract algebra to be less relevant for future mathematics teachers. The results of Astuti's research (2018) show that the difficulties experienced by students in learning Algebraic structures are as many as 62.5% of students have difficulty in solving problems, as many as 50% of students have difficulty in concepts and as many as 45.7% of students have difficulty with skills.

Students taking education in mathematics education study programs are given Abstract Algebra courses. Although students are prepared to become math teachers which gives them the possibility that they will teach school mathematics, students need to be provided with pure mathematics which is the knowledge that forms the foundation of mathematics itself. So that students can learn to form a solid understanding of mathematics itself, not only in school mathematics knowledge. Mathematics can be applied or build on other sciences, because mathematics has a consistent structure so that it can simplify and solve various problems in other fields. So it is necessary to study the structure and nature of mathematics itself. Premadasa (2013) states that the aim of higher education requiring Algebra to be a compulsory subject for most majors is to provide opportunities for students to see that mathematics is useful for their future careers and also in everyday life .

Mathematics is the study of structure, space, change, quantity and pattern. Abstract algebra studies about mathematical structures. Abstract algebra is a study that requires high-level thinking skills, namely abstraction. The Abstract Algebra course discusses 3 basic concepts namely *Groups* , *Rings* and *Fields* . Through abstraction and generalization, we can see the regular nature of mathematics and that order can be seen in God who is orderly, so that by studying the structure of mathematics itself we can admire God as a great creator. Including human logic which is capable of creating mathematical structures even though everything cannot be separated from the intervention of Allah as the creator of all things . By following the Abstract Algebra course, students are expected to be able to demonstrate an understanding of the basic definitions and theorems of Abstract Algebra , understand the relationships and roles of Abstract Algebra in high school mathematics and other fields, communicate mathematical ideas both in written and oral forms for various audiences, independently develop a higher understanding of some topic using sources other than text .

The structure of mathematics that is consistent, logical, systematic is the beauty of mathematics and makes everyone who studies it requires complex abilities, a mathematics educator needs to be able to see the beauty of the nature of mathematics. However, the complex abilities needed in learning mathematics often make it difficult for those who study it. Even though in studying mathematics many competencies develop in those who study it, not all students can understand this, so it is very necessary to communicate the ideas in it. Premadasa, (2013) said that mathematics teachers often bring mathematics into real-life applications, but still many students do not like learning mathematics and this is very popular more than the famous cartoon.

Mathematics is a study that studies assumptions, their properties and applications. In teaching mathematics, it is necessary to pay attention to the sequence of assumptions, properties, and applications and this must be maintained in teaching it to achieve the desired goals of teaching mathematics (Yadav, 2017). Algebra is also very important, but many students do not have sufficient opportunities to investigate its structure, symbols and applications (Banerjee & Subramaniam, 2012; Loveless, 2008). Through this research, it is hoped that it can bring prospective teacher students to understand the relationship between Abstract Algebra courses and find links between Abstract Algebra lectures and school mathematics through assignment design, learning activities, giving projects, essential questions during lectures involving students in understanding ideas in Abstract Algebra and relate it to school mathematics or other fields. After lectures students are led to think about why the material being taught is important to school mathematics teachers and in what ways it is important. Researchers design assignments, learning activities, projects and provide essential questions that bring students to see connections between abstract algebra courses and school mathematics. For example by asking why the product of two negative integers is positive? Why can the elimination method on a system of linear equations provide a solution? Guiding prospective teacher students to solve school math problems with

Abstract Algebra stages, connecting abstract algebra with school mathematics, using projects in lectures. The purpose of this research is to find out how the development of students' understanding as prospective teachers regarding the relationship between Abstract Algebra courses and mathematics taught in schools through each essential question and project in the form of abstract algebra applications in everyday life, school mathematics and other fields after attending lectures Abstract algebra.

Abstract Algebra and School Mathematics
Student teacher candidates often question the connection between the Abstract Algebra they learn in college and what they will teach later in school mathematics. Because these subjects require the complexity of thinking which often causes them difficulties in learning them. Christy (2015) also found the same thing that the nature of undergraduate level Abstract Algebra which has a high level of symbolism makes it difficult for students to see the relationship between the course and mathematics which will be taught at the school level. The results of the study explain that there is a bridge between Abstract Algebra courses and school mathematics. The results of Nurlaelah's research (2009) studied that with computer-based learning, recitation assignments, understanding creativity and mathematical power through teaching materials can increase creativity, problem solving abilities *(mathematical problem solving)* , mathematical communication , *mathematical reasoning* .), linking mathematical ideas *(mathematical connection),* and forming positive attitudes towards mathematics (*positive attitudes towards mathematics*). The results of Wasserman's research (2018) examined mathematics teachers in learning Abstract Algebra to develop content and methods in lectures.

During lectures researchers will start with essential questions that encourage them to think again that they need to know fundamental knowledge of mathematics so that they are able to teach school mathematics well. After lectures students are led to think about why the material being taught is important for school mathematics teachers and in what ways is it important? Students are brought in to be involved in understanding Abstract Algebraic ideas through designing assignments, learning activities, giving projects, essential questions so that they can relate them to school mathematics.

METHOD

This study used a quantitative approach with a *one-group pretest-posttest design* . Questionnaire data regarding the development of students' understanding of school mathematics before and after attending abstract algebra courses were processed using the *Wilcoxon test* . In addition, data was collected through written interviews regarding the relationship between Abstract Algebra and school mathematics through the design of assignments, learning activities, giving projects, giving essential questions in each lecture, and knowing what kinds of difficulties students experience in learning Abstract Algebra courses. The subjects in this study were 32 students of the Mathematics Education study program who took the Abstract Algebra course . Data collection was carried out throughout the research activities, to obtain complete data. The research instruments used were questionnaires and student interviews.

RESULTS AND DISCUSSION

From the results of the questionnaire, it was obtained differences in students' understanding of the importance of abstract algebra before and after attending lectures. Meanwhile, descriptive statistics from student learning comprehension data show that the mean and median after being given lectures with design assignments, learning activities, and projects (60.93 and 60.50) are higher than before lectures (57.80 and 57.50). With SPSS data processing, using a non-parametric test using the Wilcoxon test obtained a significance of <0.05, meaning the null hypothesis is rejected. This shows that there are differences in student understanding before and after being given lectures with assignment designs, learning activities, and projects. This means that giving lectures with design assignments, learning activities, and projects greatly impacts student understanding. The SPSS results show that the Z value = -2.659 and the significant value is $0.008 < 0.05$. This shows that through assignments, learning activities, projects and giving essential questions help students better understand the material being studied. In line with the results of Manandhar's research (2021) which states that one strategy for teaching abstract algebra is successful by providing concrete examples and their interrelationships.

Abstract algebra is a part of pure mathematics that studies the algebraic structure itself. So often the material in this course is considered too deep and lacks relevance to school mathematics. Especially for a mathematics education student who is being prepared to become a teacher. Therefore, researchers try to link the material studied in abstract algebra with applications in everyday school mathematics and other fields. Students are given project assignments to collect information from various sources and provide application explanations of abstract algebraic material in school mathematics, other fields and everyday life. students present their work. So students don't only learn the structure of algebra that looks abstract. After working on the project, students are given a lecture questionnaire, how is their understanding of the importance of abstract algebra material in building their school's understanding of mathematics.

Even though at the beginning of the lecture several competencies were explained that were developed in abstract algebra courses. However, by being given project application assignments from material studied in abstract algebra related to everyday life, school mathematics, and other fields students can be directly involved in building an understanding of the importance of learning abstract algebra. After working on and seeing all project assignments during lectures, all students agreed that they had a better understanding of the application or use of abstract algebra in everyday life. It can be seen that there is an increase of 39% of students agreeing that through project assignments students are increasingly aware of the use of abstract algebra in everyday life while for its relation to school mathematics there has been an increase of 25%. Students also agree that the material they learn in abstract algebra courses forms the basis or foundation for teaching school mathematics. As many as 98% of students better understand the application or use of abstract algebra in school mathematics and 95% agree that abstract algebra material is related to school mathematics. It is necessary to listen to the obstacles faced by prospective teachers in learning abstract algebra because it has the potential to improve teacher preparation programs which will have an impact on students' opportunities later to learn algebra (Jung, 2018).

From the results of the interviews through the student project, students are of the opinion that students gain new knowledge from each of their projects. Students are increasingly aware of the need to study abstract algebra courses in teaching school mathematics. In general, students think that through the project they gain new knowledge such as knowing that bells use permutation groups and Hamilton graphs to produce beautiful sounds and it turns out that the ringing of bells uses the properties of cyclic groups . In this ringing method, the domain (origin) represents the position of the bell. While the range (result area) represents the bell or the bell itself. This ring method will produce (n!) permutation sequence combinations so that it will eventually return to the initial sequence. By using permutations we can see how long it takes for the bell to ring once . The ringing method produced on large bells makes students realize that even small things like that require a mathematical formula in them.

Group theory developed in mathematics is very useful for identifying the symmetrical properties of a molecule. For example, it can explain symmetry operations and can be used to draw conclusions regarding the vibrational, electronic and electronic transition properties of a large number of certain molecules. Each symmetry operation generates a character value, so each group of points generates a specific character table. Because the symmetry operations are not only related to the cartesian axis but also to atomic orbitals as objects, these objects are reflected in a series of certain character values. All compounds have an element identity. The identity element is a symmetry operation that does not change the orientation of an object. How the element of identity in group theory can also be seen in the symmetry of inorganic molecular bonds. By grouping using the Cayley table which shows each group and also those that have group criteria (closed, identity) in an orbit. This shows that the group theory developed in mathematics is very useful for identifying the symmetrical properties of a molecule .

Groups can be found in everyday life, for example in physics, chemistry, calendars, in a game such as rubik's where the concept of identity is emphasized to be able to play it well and arrange it to its original position. We can find sub-groups in the field of Chemistry, namely silicon objects, in chords (music), minisodoku games (4x4), Addition groups in calculating days using modulo . Shows the role of set theory and group theory to analyze chords in music, namely by constructing each chord into Z12 .

Modulo is a number operation that produces the remainder of the division of a number to another number, not only used in the scope of mathematics. An example is modulo in C++ programming. Language for OOP-based software development. Apart from being used to determine the remainder of division in programming, modulo can also be used to determine even or odd of a number. In programming, to get how modulo works, we have to code it. It also describes the steps in translating and using modulo for applications, such as ATM . Max-plus algebra is an algebraic structure on a set of real numbers consisting of max-plus algebraic addition and max-plus algebraic multiplication. We can find max plus algebra in everyday life, for example in traffic controllers. In traffic control, it is impossible for vehicles to crash because they use the algebraic max plus principle. We can also see this in determining the shortest route from Google maps. Max plus algebra allows us to determine the shortest path through graph Mapping. Apart from the projects above, there are several other projects that help students understand the importance of learning abstract algebra in teaching school mathematics .

In addition to the project, the essential questions bring students to see school mathematics by the nature of the algebraic structure itself, not just by doing a demonstration at the school level. For example why 1 + (-1) = 0? Why can the elimination method on a system of linear equations provide a solution? students understand the algebraic structure itself, starting from the definition of set elements, inverses and identities as well as the theorems that build them. Mathematics is not only about patterns, but students realize that the Algebraic structure itself is built by sets and operations in which there are logical definitions and theorems .

The difficulty for students in understanding abstract algebra lectures is that there are still many students to prove by showing using numbers, not based on previous definitions or theorems that have been proven, lack of thoroughness and incomplete breakdown, do not explain concepts in detail, do not explain in more detail the proof, do not made it in the language of mathematics, confused where to start due to adapting to using definitions to prove .

CONCLUSIONS AND SUGGESTIONS

The conclusion of the research is that through a series of abstract algebra lectures students realize that abstract algebra courses are the foundation for teaching school mathematics because the use of abstract algebra material is closely related to everyday life, school mathematics and other fields. Abstract Algebra lectures help their understanding of school mathematics through learning abstract algebra. This means that students are increasingly aware of the importance of abstract algebra for a mathematics teacher candidate .

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