



Implementing the Aptitude Treatment Interaction (ATI) Learning Model for Linear Equation Systems and Matrix Materials for Prospective Mathematics Education Teacher Students

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ABSTRAK

Penelitian dengan pendekatan deskriptif kuantitatif ini bertujuan untuk melihat hasil belajar mahasiswa calon guru pendidikan matematika setelah diterapkannya pembelajaran dengan model *Aptitude Treatment Interaction* (ATI) pada materi sistem persamaan linier dan matriks. Teknik pengumpulan data pada penelitian ini adalah melalui pemberian tes dan dokumentasi. Subjek dikelompokkan ke dalam tiga kategori yaitu subjek yang memiliki kemampuan matematika tinggi, sedang, dan rendah. Hasil penelitian menunjukkan bahwa penerapan model pembelajaran ATI meningkatkan hasil belajar dengan rata-rata sebesar 78,10 sehingga masuk dalam kategori baik. Hal ini terlihat dari rata-rata hasil belajar mahasiswa secara keseluruhan baik mahasiswa yang berkemampuan matematika tinggi, sedang, maupun rendah. Sehingga dapat disimpulkan setelah menerapkan model pembelajaran *Aptitude Treatment Interaction* (ATI) bahwa *intake* mahasiswa secara keseluruhan jika dilihat dari kemampuan matematika yang dimiliki tidak menimbulkan *gap* yang lebar di antara mereka.

Kata kunci: Model Pembelajaran *Aptitude Treatment Interaction* (ATI); Sistem Persamaan Linear; Matriks.

ABSTRACT

This study aims to see the learning outcomes of prospective mathematics education teacher students after applying the *Aptitude Treatment Interaction* (ATI) learning model for linear equation systems and matrix. This study uses a quantitative descriptive approach with data collection techniques such as test and documentation. Subjects were grouped into three categories, namely subjects with high mathematical ability, medium mathematical ability, and low mathematical ability. The results showed that the application of the *Aptitude Treatment Interaction* (ATI) learning model gave a good response to learning outcomes with an average of 78.10 in the good category. This can be seen from the student learning outcomes as a whole, both students with high mathematical ability, medium, and low mathematical ability. So, it can be concluded after applying the *Aptitude Treatment Interaction* (ATI) learning model that the overall *intake* of students when viewed from their mathematical abilities does not cause a wide gap between them.

Keywords: *Aptitude Treatment Interaction* (ATI) Learning Model; Linear Equation Systems and Matrix.

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Introduction

Learning is a process that everyone goes through continuously which is not limited to space and time. Where learning is behavior that is obtained from the results of experience that is strengthened through continuous training as a new knowledge, increasing self-ability significantly. Learning point is emphasizing the principle of not knowing to become knowing. More complex is the definition of learning as revealed by Reber (1998) that learning consists of two components, namely learning is the process of acquiring knowledge and learning is a change in the ability to react to something that is constant to be dynamic. Friskilia & Winata (2018) define the learning as a change in ability or behavior which is a benchmark in determining a person's success in understanding certain material. It cannot be denied that there is a close relationship between learning and learning outcomes. Learning outcomes are obtained after a person has gone through a series of learning processes that involve various elements of attitudes, knowledge or skills. Educators certainly need to always innovate to find various strategies to improve student learning outcomes. According to Slameto (2010) there are two factors that influence learning outcomes, namely internal and external factors. Internal factor include physical (health and physical conditions of students), psychological (intelligence, attention, talent, reason, and readiness), and fatigue. While external factor include family (parent educating strategies, relationships between families, cultural background), school (curriculum, learning methods, curriculum, interaction between educators and students, learning methods), community (student involvement in society, media, and social friends). The effectiveness of using learning methods on learning outcomes turns out to be significant if the learning methods are applied properly and well by educators during the learning process (Nasution, 2018). If look at student ability, for example when talking about ability in the scope of the mathematics study program and in a smaller scope, namely in Elementary Linear Algebra course, the mathematical ability possessed by students vary. So that student learning outcomes cannot be generalized, and there needs to be grouping based on the ability to understand mathematical concepts possessed because the level of understanding of mathematical concepts for each student is different. When talking about the reality on the ground, the intake from students is very weak and there is a wide gap in mathematical understanding. This is shown from the results of the assignments given in the Elementary Linear Algebra course, it appears that there is a very wide difference in grades. This course is the basis that semester 1 students must master as capital to continue their understanding of courses in a higher semester. The gap in understanding of mathematical concepts that occurs between one student and another needs to be overcome because this causes an imbalance in the class and hinders the learning process. For this reason, it is necessary to modify learning in the classroom. The ability to understand student concepts can be improved by using appropriate learning models and approaches. The learning

model is a whole series of subject matter presentations that cover various stages of activity during the learning process and are related to all facilities that are used either directly or indirectly in the learning process (Istarani, 2011). Furthermore, Uno (2007) emphasizes that learning focuses on how to teach students and focuses on what students learn.

Among the various of learning models that teachers can apply to improve understanding of concepts, one of them is the Aptitude Treatment Interaction (ATI) learning model. The ATI learning model is a learning model that focuses on adjusting treatment during learning with differences in learner abilities (Cronbach & Snow, 1977). Furthermore Bolibaugh & Foster (2021) said that the ATI learning model can be used as a guide to the learning process which cannot be observed directly, but it can be concluded how a learning process occurs by observing student interactions with each other. The ATI learning model is a learning model that contains a number of specific treatments that are effectively used for students according to each student's level of ability (Pirayanti, 2012).

The Aptitude Treatment Interaction learning model can be carried out using the following steps (Listiani et al, 2023). Aptitude Testing: initial ability test aims to determine students' potential abilities. The initial ability test consists of giving questions both orally and in writing. Grouping of students: grouping students into three ability categories, namely high, medium and low, is based on the results of the initial ability test. Treatment: treatment for each group is adjusted to the abilities of each student. For students with high abilities, modules are given to support the learning process activities. For students with medium and low abilities, this is intensively carried out by educators (Regular learning) and tutorials. Treatment is given after students and their groups are taking part in regular learning. This is intended so that psychologically students with low abilities do not feel treated as number two students in the class. If necessary, Re-teaching and Tutorials are chosen as special treatment for the low group, based on the consideration that they are slow and difficult to understand and master the lesson material. Therefore, this group must receive special treatment in the form of guidance and learning assistance in the form of repeating lessons through additional hours of lessons (re-teaching) and tutorials (tutoring), so that in this way they can master the lessons given. Because as is known, one of the objectives of learning or tutoring programs is to provide assistance in learning to students who are slow, difficult or fail in learning, so that they can achieve optimal academic achievement/learning outcomes. Achievement test: the achievement test is carried out through several tests and improvements and revisions (within a scheduled time span), with the aim of measuring the level of students' mastery of what they have learned after implementing the learning model during learning activities.

The principle in the Aptitude Treatment Interaction (ATI) learning model is that the interaction between ability and treatment takes place in a complex pattern and is influenced by the task and learning

conditions. Learning conditions are adjusted based on the abilities of each student. The level of success (effectiveness) in implementing the Aptitude Treatment Interaction (ATI) learning model can be achieved well, so in its implementation it is necessary to pay attention and live it up based on the principles put forward by Snow (1991) namely: That the interaction between ability (aptitude) and learning treatment takes place in complex patterns, and always influenced by task/position and situation variables. Therefore, in implementing the ATI approach model, it is necessary to pay attention to and minimize the estimated bias that may originate from these variables; The influence of the environment needs to be taken into account because a structured learning environment is suitable for students with medium and low abilities, while a less structured (flexible) learning environment is more suitable for students with high abilities. The characteristics of the Aptitude Treatment Interaction (ATI) learning model include grouping students based on the students' initial abilities, then students are given treatment according to their abilities. In the Aptitude Treatment Interaction (ATI) learning process, low ability students are more suited to a structured learning environment, while high ability students are more suited to a flexible learning environment. Students who have low self-confidence are more suited to a structured learning environment, while students who have high self-confidence are more suited to a flexible learning environment (Listiani et al, 2023).

The implementing of the ATI learning model in learning places more emphasis on group work or collaboration between peers, so it is hoped that it can improve student learning outcomes. The application of the ATI learning model has a fairly good influence on problems during the learning process. One of the studies developed by Maskur (2020) said that students' creative thinking abilities increased after applying Aptitude Treatment Interaction (ATI) learning model. ATI learning emphasizes the concept that individual learners with different abilities need to be appreciated and accommodated (Gagne, 1977). Based on observations made by educators that if the ATI learning model is not implemented it will have an impact on students' understanding of content that is not comprehensive so that it will reduce the quality of graduates and student learning motivation will be lower due to lack of attention for students who have low mathematical abilities.

Some educators pay less attention to students when the learning process takes place. Students who have a good understanding of mathematical concepts will quickly feel bored and tired when studying, this is due to the tendency to repeat lessons. However, students who have deficiencies in understanding mathematical concepts will feel left out because during the learning process tends to be dominated by intelligent students. To accommodate differences in student abilities, as educators apply a learning model that can treat students according to their abilities. In this case the ATI learning model can be a solution because it can assist educators in helping students master the material being taught according to

the student's level of ability. Furthermore Septiana, et al (2021) corroborated this statement with research he conducted related to the results showing that students' mathematical understanding abilities in the learning process applied to the ATI learning model were better than the learning process using conventional learning.

To implement ATI learning model in classroom, students are classified into three groups, groups of students with high, medium, and low mathematical abilities. Student grouping in implementing the ATI learning model are adjusted based on the strategies contained in the ATI learning model. This aims to help teachers during the learning process. Then each group was given a treatment that was deemed appropriate to the characteristics of their mathematical abilities. The expectation toward implementation of the ATI model is there is no significant gap of students' ability therefore balance of understanding in class is achieved and the learning process will be going well. By the various reviews that have been put forward, it is important to conduct research entitled "Improving student learning outcomes through the Aptitude Treatment Interaction (ATI) learning model".

Research Methodology

This research uses a quantitative descriptive approach. The application of the ATI learning model was carried out in several meetings with 44 research subjects. The subjects involved in this research were students who were taking elementary linear algebra course. Analysis of the test data was carried out by grouping student scores according to the categories of achievement of student learning outcomes in the material system of linear equations and matrices based on Table 1.

Table 1. The Classification of Achievement of Student Learning Outcomes

Grade	Category
86-100	Verry good
71-85	Good
56-70	Moderate
≤55	Low

(Kemdikbud, 2015)

At meetings 1 to 3, students with high mathematical abilities are provided with modules for independent study which can hone their mathematical skills. Meanwhile, students with moderate and low abilities are guided by the subject's lecturers to be able to better understand the concept of a system of linear equations and matrices so that they can improve their mathematical abilities. At the fourth meeting a learning evaluation was carried out which aimed to see whether there was an increase in student learning outcomes after the implementation of the ATI learning model.

Result and Discussion

The grouping of subjects based on their initial mathematical ability which refers to data on student learning outcomes that are already possessed by educators is carried out before the research begins. In several meetings before the implementation of the ATI learning model, educators carried out initial ability tests. The initial ability test aims to determine students' initial mathematical abilities, which then from the test results are grouped based on their mathematical abilities, namely high, medium and low abilities. From the results of the mathematics initial ability test, a percentage of 100% was obtained for high-ability subjects who scored above the minimum score, for moderate-ability subjects, a percentage of 25% obtained below the minimum score, while for low-ability subjects obtained scores below the minimum score with a percentage of 100%. Based on the scores of the early math skills test, it is very appropriate to apply the ATI learning model. Where educators make modules for high-ability subjects to learn independently, so that educators can focus more on guiding low-ability subjects. Given the importance of linear equation learning systems and matrix, students who still have difficulty understanding the material, it is necessary to develop a learning model that includes several learning strategies by developing the following conditions: effective learning conditions for students with different skill groups: high, medium, and low (Kusumawati & Ruslan, 2016).

Implementation of learning by applying the ATI model is preceded by conducting outreach to students so that students understand their respective functions so that the learning scenario runs smoothly. It is important to carry out socialization with the aim of providing insight into what the subjects are and how the process of implementing the ATI learning model is carried out. So that the aim of implementing the ATI learning model can be achieved. The ATI learning model was applied in three meetings then at the fourth meeting a learning evaluation was carried out to see if there was an increase in the subject's learning outcomes. At the learning implementation stage, the research subjects were grouped and given unequal treatment. Subjects with high abilities are given modules to be studied independently, while subjects with medium and low abilities are explained by educators regarding lecture material. In addition, educators also provide opportunities for students to respond, ask questions, or submit opinions to each other so that the learning process takes place interactively which can lead to students' critical thinking skills (Fauzan et al, 2022). Educators also provide opportunities for students to conclude lecture material.

The learning process with the application of the ATI learning model shows significant results. This can be seen from student responses both in terms of liveliness, the students abilities to express opinions, ask questions related to material that has not been understood. It even seems that high-ability

students can help students who don't understand the lecture material. Student motivation and enthusiasm for learning are clearly visible during the learning process. The Aptitude Treatment Interaction learning model is very good for use in the learning process considering that in its implementation students are directly involved in the learning process by providing opinions, criticism, reinforcement or rebuttal during group discussion activities. In this way, students can indirectly increase their understanding of the subject matter being studied, so that students' learning outcomes increase. This happens because students do not just know information or lessons from the teacher's explanations in the classroom, but students immediately explore understanding by actively searching for and discovering for themselves the concepts of the material taught at each level of their group (Saregar et al, 2017).

The test was carried out at the fourth meeting. The test results obtained by students on systems of linear equations and matrices are shown in Tables 2, 3, 4, and 5.

Table 2. The grade of Students with High Ability

Grade	Frequency	Classification
86-100	7	Very good
71-85	-	Good
56-70	-	Intermediate
≤55	-	Deficient
Number of students	7	
Score total of students	654,39	
Mean	93,48	Very good

There was no significant difference in the learning outcomes of high-ability subjects before and after the implementation of the ATI learning model. This is shown in the large percentage before and after the implementation of the ATI learning model with an average learning result of 93.48 which is categorized as very good.

Table 3. The grade of students with moderate ability

Grade	Frequency	Classification
86-100	7	Very good
71-85	5	Good
56-70	-	Intermediate
≤55	-	Deficient
Number of students	12	
Score total of students	1012,36	
Mean	84,36	Good

After applying the ATI learning model, the average learning outcomes of subjects with moderate abilities were 84.36 in the good category.

Table 4. The grade of students with low ability

Grade	Frequency	Classification
86-100	2	Very good
71-85	8	Good
56-70	14	Intermediate
≤55	1	Deficient
Number of students	25	
Score total of students	1769,60	
mean	70,78	Good

Learning outcomes for low-ability subjects after the implementation of the ATI learning model with an average learning outcome of 70.78 in the good category. The average learning outcomes of mathematics education students in the material system of linear equations and matrices as a whole can be seen in Table 5.

Table 5. The grade of students with high, medium, and low ability

Grade	Frequency	Classification
86-100	16	Very good
71-85	13	Good
56-70	14	Intermediate
≤55	1	Deficient
Number of students	44	
Score total of students	3436,35	
mean	78,10	Good

From Table 5 it can be seen that the learning outcomes of mathematics education students in the material system of linear equations and matrices is 78.10 which is categorized as good. Based on the data, it can be concluded that the application of the ATI learning model can improve student learning outcomes in Elementary Linear Algebra courses. The results of this study are supported by several studies that have implemented the ATI learning model to improve student learning outcomes. Among them, research conducted by Bakri, et al (2020); Wirahmad et al (2020) said that the application of the ATI learning model can improve understanding of mathematical concepts and student learning outcomes.

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Conclusion

Based on the results of the analysis of student answers and the scores obtained, there were significant changes before and after the Aptitude Treatment Interaction (ATI) learning model was applied. The average student learning outcomes with high ability is 93.48 which is categorized as very good. Meanwhile students with moderate and low abilities respectively obtained learning outcomes with an average of 84.36 and 70.78 which were categorized as good. Overall, the average student learning outcomes in material systems of linear equations and matrices, namely 78.10 are in a good category. This shows that the intake of students as a whole when viewed from their mathematical abilities after the implementation of the Aptitude Treatment Interaction (ATI) learning model has increased, so that it does not cause a wide gap among them.

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