UJME 7 (1) 2018: 17-23
UNNES JOURNAL OF MATHEMATICS EDUCATION
https://journal.unnes.ac.id/sju/index.php/ujme/
ISSN: 2252-6927 (print); 2460-5840 (online)

The effectiveness of auditory intellectually repetition learning aided by questions box towards students' mathematical reasoning ability grade XI SMA 2 Pati

Arief Agoestanto [a,*], Oei Yuda Setiyo Priyanto[a], Bambang Eko Susilo[a]

[a] *Universitas Negeri Semarang, D7 Building First Floor, Sekaran Campus Gunungpati, Semarang 50229, Indonesia*

* *E-mail address: arief.mat@mail.unnes.ac.id*

ARTICLEINFO

Article history:
Received 3 July 2017
Received in revised form 1 March 2018
Accepted 6 March 2018

Keywords:
AIR learning model;
Mathematical Reasoning Ability;
Questions Box

Abstract

The objective of this study is to determine does the AIR learning is effective towards students' mathematical reasoning ability grade XI SMA 2 Pati on the sequence and the series material. The population in this study is all students grade XI SMA 2 Pati Academic Year 2016/2017. The method used in this study is quantitative method. While the data collection includes test methods, questionnaires, and observations. The results showed that: (1) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR learning model is reaching the mastery learning; (2) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR learning model aided by Questions Box is reaching the mastery learning; (3) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR model aided by Questions Box is better than the mathematical reasoning ability of students who learn with AIR learning model and expository learning model; (4) the mathematical reasoning ability of students grade XI SMA 2 Pati who learn with AIR model aided by Questions Box is better than the mathematical reasoning ability of students who learn with AIR learning model and expository learning model for each group, either low, medium or high. Based on the four results of the above research, it can be concluded that the AIR learning aided by Questions Box is effective towards students' mathematical reasoning ability grade XI SMA 2 Pati on the sequence and series material.

1. Introduction

Mathematics is a science derived from the results of human thought and learned by reasoning. Depdiknas, as quoted by Shadiq (2004), states that mathematical material and mathematical communication and mathematical reasoning have a very strong and inseparable linkage. Mathematical material can be understood and communicated through reasoning. While reasoning is understood and enhanced through learning mathematical material.

Regulation of National Education Ministry (Permendiknas) number 22 in 2006 states that the mathematics lesson goals are students are expected to have ability: (1) to understand the concepts of mathematics, explain correlations and apply concepts of algorithms, flexibly, accurately, efficiently and appropriately solve the problems; (2) use reasoning in patterns and traits, performe mathematical manipulations in generalizing, collecting evidences, or explaining mathematical ideas and statements; (3) solve the problems that include the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained; (4) communicate the ideas with symbols, tables, diagrams, or other media to clarify circumstances or problems; and (5) have an appreciative attitude to the use of mathematics in life, and also a curiosity, attention, and interest in learning mathematics, as well as a tenacious attitude and confidence in problem solving.

According to Mueller & Maher (2009), reasoning is a process that allows to review and rebuild previous knowledge in order to build new arguments. Ross (in Lithner, 2000) says that one of the most important goals of mathematics course is

To cite this article:
Agoestanto, A., Priyanto, O. Y. S., & Susilo, B. E. (2018). The effectiveness of auditory intellectually repetition learning aided by questions box towards students' mathematical reasoning ability grade XI SMA 2 Pati. *Unnes Journal of Mathematics Education*, *7*(1), 17-23. doi: 10.15294/ujme.v7i1.15828

to teach student a logical reasoning. In fact, Ball, Lewis & Thamel (in Burais, Ikhsan, & Duskri, 2016) add that mathematical reasoning is the foundation for the construction of mathematical knowledge. With the ability of mathematical reasoning, students can also decide better decisions by collecting the facts and considering the consequences of the various options (O'Connell, 2008). Therefore, students' reasoning which is one of the abilities that must be possessed by students in learning mathematics, should be more paid attention by the teacher.

The indicators of mathematical reasoning ability used in this study are (1) the ability to find patterns or properties of mathematical phenomena to generalize; (2) the ability to file conjectures; (3) the ability to arrange the proof, give a reason or proof to the truth of the solution; (4) the ability to do mathematical manipulation; (5) the ability to make a conclusions from the statements; (6) the ability to check the validity of an argument (Wardhani, 2010).

According to TIMSS data in 2015, Indonesia was ranked 45 from 50 countries with a score of 397. While according to PISA results in 2015, Indonesia was ranked 62 from 70 countries with a score of 386 (OECD, 2015). Based on two results, it is shown that Indonesian students' mathematics skills for Elementary School (SD/MI) and Junior High School (SMP/MTs) are not satisfactory on the international level. Again, according to Wardani & Rumiyati (2011), the results of TIMSS and PISA's low evaluations are certainly caused by several factors. One of them is Indonesian students are generally poorly trained in solving the problems tested in TIMSS and PISA, which are contextual, demanding reasoning, argumentation and creativity in the settlement. It means that students in SD/MI and SMP/MTs have not been able to optimally engage their mind and creativity, so that they have difficulties in solving problems related to reasoning.

With regard to above explanation, if the mathematics ability of students in elementary and junior high school is still low, it is assumed that students' mathematics ability in the next education level is also low due the basic concept of mathematics builds hierarchy in a more complex structure (Suyitno, 2014). In addition, its learning follows spiral method which means that in each new mathematical material introduction, it is necessary to pay attention to what previous students have learned. A new knowledge is always associated with what has been learned (Suherman, 2003). This is also expressed by Hudojo (2005), who adds that learning is an active process in gaining experience or new knowledge from what has been previously learned.

Based on the result of mathematics national exam of SMA 2 Pati for three years in a row, it means that the average value has decreased significantly as presented in the following table 1.

Table 1. The average value of mathematics national exam

Study Program	Academic Year		
	2013/2014	2014/2015	2015/2016
Science	77,00	66,26	65,32
Social	75,00	76,24	64,61

Based on the observation results, the teacher has given enough stimulus, yet in fact the students are still difficult to present an assumption and draw conclusions from the stimulus-stimulus given. As a result, when they are asked to solve problems that require reasoning, the teacher must lead them back in the process. In fact, from the interview results, students are only oriented to the results of learning regardless of their reasoning abilities in solving problems and still focused on the formula. This indicates that the indicators of ability to guess, the ability to perform mathematical manipulation, and ability to draw conclusions have not been found in the students of SMA 2 Pati. Therefore, a mathematics learning model is needed to support the indicator.

One model that allegedly can motivate, encourage, and support the achievement of students' mathematical reasoning abilities in a lesson is the Auditory Intellectually Repetition (AIR). AIR model is one of the learning models that emphasizes three aspects, namely auditory, intellectually, repetition. First, the auditory implies that in the learning process, students use the five senses in terms of listening, giving opinion, and responding to the results of the discussion. Second, intellectually implies that the ability to think, need to be trained through the process of reasoning, creating, solving problems, constructing, and applying. Third, repetition implies that in learning needs a repetition in order the concept which is taught easily to be accepted and deeply understood through the work of questions, assignments or quizzes (Latifah & Agoestanto, 2015).

Moreover, in the AIR learning model syntax, there are several stages that must be implemented so that the learning objectives can be achieved, including the delivery stage, the training phase and the result presentation (Dave, 2002). At the delivery stage, teachers provide contextual issues that stimulate students to guess. In the training phase, teachers direct and facilitate students to engage in intellectual activity packaged in group discussions (3-4 students) and in which students have the opportunity to express opinions, gather information, problems (auditory and intellectually). While at the results presentation stage, students are asked to conclude and apply new knowledge which is gained through the work of the problem individually (repetition). Therefore, by using the AIR model, it is also expected being able to improve students' mathematical reasoning abilities.

In addition, the use of varied media is also required by teachers when teaching process. Syahlil (2011) argues that the Questions Box is one of media which is expected to help students during the learning process to stimulate students' emotional and intellectual involvement in proportion. Basically, learning activities using Questions Box media is divided into three stages: group orientation, work in group, and collective evaluation (Syahlil, 2011). In the work in group stages, students conduct discussion activities to solve problems according to the questions which are taken from the Questions Box. While the teacher only acts as a facilitator for each group. He/she monitors the student's learning activities, provides assistance when it is necessary, fosters the student's skills in guessing, manipulating mathematics, and estimating the appropriate strategy as the solution of the question.

Above all, the objective of this study is to determine does the AIR learning is effective towards students' mathematical reasoning ability grade XI SMA 2 Pati on the sequence and the series material.

2. Method

The method of this study is quantitative method. The data collection includes test methods, questionnaires, and observations. Furthermore, this study used the experimental design of True Experimental Design with Posttest-Only Control Design. In this design, there are three groups selected randomly. The first group received treatment in the form of AIR model learning as the 1st experiment class. The second group received treatment in the form of learning with AIR model with the help of Questions Box as the 2nd experiment class. While the third group did not get special treatment or commonly referred to as control class. After getting different treatment, the three classes were given posttest to know the students' mathematical reasoning ability in the three samples**.**

The study was conducted at SMA 2 Pati academic year 2016/2017. The population in this study were all students of class XI with XI-Science 2, XI-Science 3, and XI-Science as 4 study samples. The sampling was done by cluster random sampling technique. While the statistical test used is the proportion test π one tailed, one way anova test and LSD advanced test with the help of SPSS 16.0 program.

3. Result & Discussion

The data processing is conducted in order to know the effectiveness of AIR learning through Questions Box on students' mathematical reasoning ability which is done in three steps. The first step is to test the proportion of a student to test his/her mathematical reasoning ability by using AIR learning model along with Questions Box. The second step is to test one way anova and further continued by LSD test to find out the difference of students' mathematical reasoning ability who learn with AIR learning along with Questions Box, with AIR learning model, with expository learning model. Eventually, it is done to know which one is the best. The last step is to test one way anova and LSD advanced test to find out the difference of students' mathematical reasoning ability who learn with AIR learning model along with Questions Box, with AIR learning model, with expository learning model for each group based on initial ability mathematics level and in the end to know which one is the best.

The π proportion test is done by using the Ms Excel program. The results of this test can be seen in the following table.

Table 2. The Result of The π Proportion Test

Class	$z_{(0,5-\alpha)}$	z_{calc}	Conclusion
1st experiment	1,645	1,981	$z_{calc} > z_{(0,5-\alpha)}$
2nd experiment	1,645	2,363	$z_{calc} > z_{(0,5-\alpha)}$

Based on the table, the z_{calc} value for the 1st experiment class is 1,981 and the z-count for the 2nd experiment class is 2,363. While the value of z_{table} is found by using standard normal distribution table with the level of significance (0, 5- α). It is obtained that z_{table} value is 1,645. Because $z_{calc} > z_{(0,5 - \alpha)}$, then H0 is rejected. It means that the percentage of the 1st experiment class and the 2nd experiment students who achieve a mastery are over 75%. Meanwhile, one way anova test and LSD is assisted by SPSS 16.0 for windows. Its results can be seen in the following table.

Table 3. The Result of One Way Anova Test

ANOVA

VALUE	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.820,96	2	910,48	15,74	,000
Within Groups	6.074,03	105	57,85		
Total	7.894,99	107			

Table 4. The Result of LSD Test

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	4,833	0,008	significant
1st experiment > control	5,222	0,004	significant
2nd experiment > control	10,056	0,000	significant

Based on tables above, the significance value in the anova test is 0,000. Since the significance value is less than 0, 05, then H_0 is rejected. It means that there is a significant average difference between the control class, the 1st experiment class, and the 2nd experiment class. To find out which one is the best, then the LSD advanced test is done. The result of the test shows that the average value of mathematical reasoning ability of the 1st experiment class and the control clas are significantly difference. The average value of mathematical reasoning ability of the 2nd experiment class and the control class are also significantly difference. Meanwhile, the average value of the mathematical reasoning ability of the 1st experiment class and the 2nd experiment class are also significantly difference. It shows that students' mathematical reasoning abilities using AIR learning model along with Questions Box are better than students' mathematical reasoning abilities using AIR learning models and expository learning models. In other words, the use of the AIR learning model along with Questions Box can improve students' mathematical reasoning abilities.

To find out whether students' mathematical reasoning ability who learn with AIR learning model along with Questions Box, with AIR learning model, and with expository learning model for the low, medium, and high groups, further one-way anova and LSD-test are also tested. From the calculation result of one way anova test for each group, the value of significance in anova table is 0.001; 0,000; and 0,001. Because the significance value of each group is less than 0.05, then H_0 is rejected. It means that there is a significant mean difference between the control class, the 1st experiment class, and the 2nd experiment class for the low, medium, and high groups.

Besides, to find out which the best learning model of mathematical reasoning ability for each group, LSD test is done and it is obtained that the average value of mathematical reasoning ability of 1st experiment class and control class are significantly difference, so the 2nd experiment class and the control class are. Meanwhile, the mean value of the mathematical reasoning ability of the 1st experiment class and the 2nd experiment class are significantly difference. It applies to low, medium, and high groups as presented in the following Tables 5, 6 and 7.

Table 5. The Result of LSD Test for Low Group

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	8,833	0,016	significant
1st experiment > control	7,167	0,043	Significant
2nd experiment > control	16,000	0,000	Significant

Table 6. The Result of LSD Test for Medium Group

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	3,583	0,042	significant
1st experiment > control	4,958	0,006	significant
2nd experiment > control	8,542	0,000	significant

Table 7. The Result of LSD Test for High Group

Comparison of Sample Group	Mean Difference	Sig.	Decision
2nd experiment > 1st experiment	5,833	0,011	significant
1st experiment > control	4,333	0,049	significant
2nd experiment > control	10,167	0,000	significant

Based on the tables above, it can be concluded that students' mathematical reasoning abilities using AIR learning model along with Questions Box is better than the AIR learning model and expository learning model. Not only as a whole but also for low, medium and high groups.

Based on the students' test results from the three classes, there are also differences in how and the results of the test questions of mathematical reasoning ability are. The assessment of students' mathematical reasoning abilities is based on predetermined indicators which had been made in the lattice making. After analyzing student test result based on indicator of mathematical reasoning ability, it is obtained that the percentage of students who meet the six indicators of mathematical reasoning ability is the higher is 2nd experiment class than control class. While, the 1st experiment class is shown in the following table.

Table 8. The Result of Students Posttest Analysis in Control Class, 1st Experiment Class, and 2nd Experiment Class Based On The indicators of mathematical reasoning ability

Indicator	Control	1st experiment	2nd experiment
1	84,19%	87,18%	88,68%
2	87,96%	88,89%	90,28%
3	67,36%	79,17%	80,21%
4	75,84%	84,40%	85,86%
5	78,70%	85,65%	87,50%
6	66,78%	70,95%	80,44%

Meanwhile, the causing factors of the students' average mathematical reasoning abilities difference who received learning with AIR learning model along with Questions Box, AIR learning model, and expository learning models were in both experiment classes, the activities were more centered on the students. They are stimulated at the beginning of learning with challenges about problem solving and activities that lead them to discover a concept, such as arranging matchsticks with different arrangements and cutting folded paper into pieces. As the result, they have prepared the previous learning, so the learning is more effective with the students' readiness. It is line with Hudojo (2005) that the failure or success of learning depends on the students, such as how students' ability and readiness to follow the learning activities of mathematics. While the activities in the control class more focused on the teacher. It means that they are more instrumental in delivering the material.

Based on the analysis of student activity on the observation sheets, it is obtained that the percentage of students in answering the prerequisite question posed by the teacher is less than 50%. It shows that students' readiness to the subject matter still lakes. In addition, in the 1st experiment class and the 2nd experiment class, students are more involved in group discussion activities consisting of 3-4 students. With group discussion activities, they absorb more knowledge, increase the intensity of the thinking process, and have the learning experience to be used as new knowledge. This is in line with the opinion of Vygotsky (Rifa'i & Anni, 2011), that is cognitive abilities derived from social and cultural relations. While in the control class, the discussion that occurred just a discussion between students when the teacher asked something.

Basically, the learning model used in the 1st experiment class and the 2nd experiment class is the same that is the AIR model. AIR learning model is a learning model that optimally involves students' sense and emotional tools and emphasizes on three important aspects of learning, namely auditory, intellectually and repetition. Dave (2002) found that aspects in intellectually in learning will be trained if students are involved in problem-solving activities, analyzing experiences, working out strategic planning, creating creative ideas, searching and filtering information, finding questions, creating mental models, applying new ideas, creating personal meaning and predict the implications of an idea. The difference is only in the learning media used. The 2nd experiment class uses LKS and Questions Box which requires students' activeness to understand and find the concept of sequence and series and apply the concepts in solving complex and varied problems, so they are constantly encouraged to be actively thinking by practicing different reasoning

problems and resolution strategies, differ from the Questions Box. While the 1st experiment class only uses LKS only and focuses on the discovery of concept and application of the concept of one problem only. This is in line with Bruner's learning theory (Slameto, 2010) that it requires the active participation of each student through exploration activities, new unknown discoveries or similar notions of familiarity, and a well-recognized diversity of abilities. Thus, the reasoning activity is more formed in the 2nd experiment class.

4. Conclusion

Regarding to above-mentioned description of analysis, it can e concluded that (1) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR learning model has eached the mastery learning; (2) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR learning model along with Questions Box has reached the mastery learning; (3) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR model along with Questions Box is better than those who learn with AIR learning model and expository learning model; (4) students' mathematical reasoning ability grade XI SMA 2 Pati who learn with AIR model along with Questions Box is better than those who learn with AIR learning model and expository learning model for each group, either low, medium or high; (5) the AIR learning along with Questions Box is effective towards students' mathematical reasoning ability grade XI SMA 2 Pati on the sequence and series material.

Reference

Burais, L, Ikhsan, M, & Duskri, M. (2016). Peningkatan Kemampuan Penalaran Matematis Siswa Melalui Model *Discovery Learning. Journal Didaktik Matematika, 3*(1).

Dave, M. (2002). *The Accelerated Learning Handbook: Panduan Kreatif & Efektif Merancang Program Pendidikan dan Pelatihan*. Bandung: Kaifa PT. Mizan Pustaka.

Hudojo, H. (2005). *Pengembangan Kurikulum dan Pembelajaran Matematika*. Malang: Universitas Negeri Malang, 125-126.

Latifah, N. U. & Agoestanto, A. (2015). Keefektifan Model Pembelajaran AIR dengan Pendekatan RME terhadap Kemampuan Komunikasi Matematik Materi Geometri Kelas VII. *Unnes Journal of Mathematics Educations, 4*(1).

Lithner, J. (2000). Mathematical Reasoning in School Tasks. *Educational Studies in Mathematics, 41*(2), 165-190.

Mueller, M. & Maher, C. (2009). Learning to Reason in an Informal Math After-School Program. *Mathematics Education Research Journal, 21*(3), 7-35.

O'Connell, J. (2008). *Mathematics Study Guide*. Sacramento: California Department of Education Press.

OECD. (2015). *PISA 2012 Result in Focus-What 15-years-old know and what they can do with what they know*. Programme for International Student Assessment.

Peraturan Menteri Pendidikan Nasional Republik Indonesia Nomor 22 tahun 2006 tentang Standar Isi Sekolah Menengah. (Decree of The Indonesian Minister of National Education Number 22, 2006).

Rifa'i, A & Anni, C. T. (2011). *Psikologi Pendidikan*. Semarang: UPT Unnes Press.

Shadiq, F. (2004). Penalaran, Pemecahan Masalah dan Komunikasi Dalam Pembelajaran Matematika. *Makalah disajikan pada Diklat Instruktur/ Pengembang Matematika SMP Jenjang Dasar Tanggal 10-23 Oktober 2004*. PPPG Matematika. Yogyakarta.

Slameto. (2010). *Belajar dan Faktor-Faktor yang Mempengaruhinya*. Jakarta: Rineka Cipta.

Suherman, E. (2003). *Strategi Pembelajaran Matematika Kontemporer.* Bandung: JICA.

Suyitno, H. (2014). *Pengenalan Filsafat Matematika.* Semarang: Universitas Negeri Semarang.

Syahlil, S. (2011). Question Box, Inovasi Media Pembelajaran di Sekolah. (*Research report*). Sidoarjo: SMK YPM 8 Sidoarjo.

Wardhani, S. (2010). *Teknik Pengembangan Instrumen Hasil Belajar Matematika di SMP/MTs*. Yogyakarta: PPPPTK Matematika.