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IMPROVING STUDENTS' MATHEMATICAL COMMUNICATION SKILLS ON DATA PROCESSING LEARNING MATERIALS THROUGH THE AIR (AUDITORY, INTELLECTUAL, REPETITION) LEARNING MODEL

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PENINGKATAN KEMAMPUAN KOMUNIKASI MATEMATIS SISWA PADA MATERI PENGOLAHAN DATA MELALUI MODEL PEMBELAJARAN AIR (*AUDITORY, INTELLECTUAL, REPETITION*)

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Abstract: *Conveying ideas is needed to direct mathematical communication skills. In fact, mathematical communication abilities are indicated not to be maximized. Several conditions imply that the students' mathematical communication skills are less than optimal, one of which is teacher-based learning. In this paper, the research was conducted specifically to measure the improvement of students' abilities in mathematical communication by applying the AIR model to data processing learning material. The research was conducted using a quasi-experimental method with the Nonequivalent Control Group design. The results of the initial and final tests of students' mathematical communication skills indicate an improvement. The students at Grade V of SD Negeri Pataruman and SD Negeri Darmaraja I were the control and experimental classes for the research sample. Sampling was carried out using a purposive sampling technique. The results of the data analysis indicate that the students' mathematical communication skill average score of the experimental class applying the AIR model was higher than the control class score by applying conventional learning. In the experimental class, the average score of mathematical communication skills was 43,34% in medium interpretation. Meanwhile, in the control class, the average score was 13,06% with a low interpretation. The description implies that the treatment in the experimental and control classes improves the students' mathematical communication skills differently.*

Keywords:* *mathematical communication skills, AIR learning model, data processing learning material

Abstrak: Menyanpaikan ide atau gagasan diperlukan keterampilan komunikasi matematis yang terarah. Fakta dilapangan menyatakan kemampuan komunikasi matematis dalam kenyataannya terindikasi kurang maksimal. Terdapat beberapa kondisi yang membuat kemampuan komunikasi matematis peserta didik kurang maksimal, satu diantaranya adalah pembelajaran yang bertumpu pada guru. Pada artikel ini, penelitian dilakukan secara khusus untuk mengukur peningkatan kemampuan peserta didik dalam komunikasi matematis mengalokasikan model AIR dalam materi pengolahan data. Penelitian dilakukan menggunakan metode kuasi eksperimen dengan desain *The Nonequivalent Control Group*. Hasil tes awal dan akhir kemampuan komunikasi matematis peserta didik menunjukkan adanya peningkatan. Peserta didik kelas V SD Negeri Pataruman dan SD Negeri Darmaraja I dijadikan sebagai kelas kontrol dan eksperimen untuk sampel penelitian. Penentuan sampel dilakukan dengan teknik *sampling purposive*. Hasil analisis data menunjukkan peningkatan kemampuan komunikasi matematis kelas eksperimen yang mengimplementasikan model AIR lebih tinggi dibandingkan dengan kelas kontrol yang mengimplementasikan pembelajaran konvensional. Pada kelas eksperimen, rata-rata peningkatan kemampuan kommunikasi matematis sebesar 43,34% pada interpretasi sedang. Sedangkan pada kelas kontrol rata-rata peningkatannya sebesar 13,06% dengan interpretasi rendah. Uraian tersebut menerangkan bahwa perlakukan dikelas eksperimen dan kelas kontrol meningkatkan kemampuan komunikasi matematis peserta didik secara berbeda.

Kata Kunci:* *kemampuan komunikasi matematis, model pembelajaran AIR, materi pengolahan data

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INTRODUCTION

Learning consists of two activities: learning and teaching. The return of students, teachers, and the environment in achieving a goal of understanding is the existence of the learning process (Diana & Rofiki, 2020). Ideally, learning can challenge students and help them solve problems to apply them in all fields. Among the many subjects that provide challenges in problem-solving is mathematics. Mathematics was born as a crucial subject in all fields and things that cannot be removed in school to be given to students (Melati et al., 2017). Following this statement (Permendiknas No. 22, 2016), all students should be taught mathematics with access to the ability to think, argue, critically, analytically, systematically, critically, and creatively as well as collaboratively.

Abstract mathematics is a science that supports all aspects of life. Mathematical learning is needed to help students solve problems, reason, and communicate ideas mathematically (Istikomah et al., 2022). Mathematics is implemented so that students not only know but understand what they learn (Gusnidar et al., 2017). Mathematics is understood through reasoning so that it can communicate mathematical material well and the results of learning mathematics are maximized (Riswandha & Sumardi, 2020). The National Council of Mathematical Teachers (NCTM) in 2000 decided on five standards of skills that must be mastered by students through mathematical lessons, namely: 1) problem-solving; 2) argument and confirmation; 3) contact; 4) association; and 5) overview (Hanisah & Noordyana, 2022). In addition, NCTM sets five standards of mathematical learning procedures, one of which is the delivery of perceptions or ideas (Ulfah & Felicia, 2019)

Mathematical communication skills are required to convey ideas. The skills that must be developed by students are mathematical communication skills (Hanipah & Sumartini, 2021). Mathematical communication is a tool used to communicate thoughts or ideas about mathematics through the use of graphs, tables, and real curves, as well as mathematical symbols (Astuti & Leonard, 2015). Mathematical communication skills give the student the passion and opportunity to express opinions, write, read, and listen to mathematical statements, as well as the student can communicate with them because mathematics is applied symbolically, verbally, and in writing (Laia & Harefa, 2021). According to NCTM, developing mathematical communication skills is a learning goal. Therefore, learning mathematics is aimed at developing those abilities so that those taught not only master math but also perform maximally (Muliana & Nuraina, 2020). In conjunction with this, (Wahyuni et al., 2018) explain that through mathematical communication, learners are able can te, consider, and expand their ability to think mathematically. It can be concluded that mathematical communication needs to be developed and mastered and thus learners can make coherent and different arguments.

The mastery of such mathematical communication can be seen from the accuracy and fulfillment of indicators of mathematic communication abilities (Melinda & Zainil, 2020). The following indicators of the ability to communicate mathematically include: 1) writing with certainty and accuracy, the

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student is required to record the information of the problem in a mathematical, logical, definite, also collected rough way, 2) describing mathematics, for this indication the student was required to paint images, diagrams, and tables comprehensively and completely, 3) mathematic formulas, this part of the student has been asked to practice the maths, then do precision or look for a solution to the problem integrally and accordingly (Husna et al., 2016).

The real facts seem very different from what should have happened. The significance of actual mathematical communication skills indicates that these aspects of the learning process are not fully used (Sumartini, 2019). The results of the PISA survey in 2015 showed an average of 386 out of the 490 standard values set by the OECD in 2018 (Tiara et al., 2020). According to previous findings of the researchers, of the 32 students, who were able to speak math effectively only 37.5%, while 62.5% were less skilled (Husna et al., 2016). Then the results of the PISA in 2018 scored 71% in terms of mathematics, Indonesian pupils are at an early level. The literacy competence of Indonesian students is on average level 2 according to PISA (Miftahussa'adah & Izzati, 2022). The low ability of mathematical communication is based on several conditions, one of which is the learning that is implemented in the teacher center. Many of the teaching activities performed by teachers in Indonesia are still using conventional learning methods, namely lectures where the learning process is more focused on the teacher than on the student (Suryana et al., 2021). Learning that takes place in the classroom is still dependent on the teacher, not practicing the learning model required to meet the needs of mathematical communication (Melinda & Zainil, 2020). Similarly, previous research interviews revealed that teaching mathematics in schools still relies on traditional teaching, where teachers work as the only informant and view that children can only observe and understand every given explanation (Syarif et al., 2022). Although basically no best or correct learning method or model because in every process many factors influence each other (Isrok'atun, 2021). Teachers who do not master the material will influence the attitude of students in the learning process, and the conditions in the classroom will not be conducive (Rosarina et al., 2016). The student does not play a role as well as active while learning as a result of which the student is passive and there is no opportunity to ask or argue. Then it is necessary to change the model of learning, learning strategy, and method of learning to reach the goal of learning.

To create good mathematical communication, teachers should pay attention to each process of teaching activities. In line with (Miftahussa'adah & Izzati, 2022) to establish good mathematical communication skills, then a model, one of which is the auditory, intellectual, repetition (AIR) model as an alternative to help students communicate more effectively in mathematics. The auditory learning model, intellectually, repetition, or in this research called the AIR model, is a type of cooperative learning. The model AIR makes the students serious and have creative powers (Bonatua et al., 2021). The AIR model is called a model that involves the entire human senses when teaching aims to focus the thinking of the student only to practice (Miftahussa'adah & Izzati, 2022).

The AIR model emphasizes three skills: auditory which prioritizes the aspects of speaking and listening, intellectually accentuating the use of thinking skills, and repetition learning with repetition (Yunita et al., 2016). At the auditory stage, the learning process is carried out by listening, speaking, and responding. The intellectual stage process of thinking such as solving, evaluating, and thinking about solutions to the problem presented. After the repetition stage, there is a re-training process of what has been taught (Gustriyana & Amelia, 2017).

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According to the above problem description, the researchers identified alternative solutions with the research entitled "Improving Student Mathematical Communication Abilities on Data Processing Materials Through AIR Learning Model (Auditory, Intellectual, Repetition)" with attention to the explanation of facts and data. Implementation of the AIR model, learning about data processing, as well as students of class V of the basic school is a special feature or differentiator of this research aimed at previous research. The purpose of this study is to find out the increase in students' mathematical communication skills in data processing material after getting the AIR model; find out the difference in increasing students' mathematical communication abilities in data processing material between the experimental class and the control class; as well as to determine student responses to the AIR model.

RESEARCH METHOD

Research carried out using experimental quarters aimed at determining the causal relationship between bound variables and free variables (Mawaddah et al., 2017). According to (Sugiyono, 2016), designs whose external variables are not entirely controlled at the time of experiment execution are referred to as semi-experiment designs or experiment questions. Time Series Design and the Nonequivalent Control Group Design or unequivocal control group outline two types of experimental research designs (Sugiyono, 2013). The Nonequivalent Control Group Design is the design implemented in this study. AIR models are implemented in experimental classes and learning control classes are carried out conventionally.

Table 1. Research Design

Sample			
Experimental class	0	X_1	0
Control class	0	X_2	0

Description:
0 = *Pretest*
X_1 = AIR model
X_2 = Conventional Learning
0 = *Posttes*

Test instruments are used to assess the learners' skills when delivering ideas on the research data processing material. At the beginning and end of the meeting, both the experimental class and the control class completed the mathematical communication skills. This study used three indicators of access to mathematical communication capabilities, indicators are taken from the perspective of Sumarmo: 1) associate math concepts with real objects, images, and diagrams; 2) use math language to describe everyday events; 3) speak or write about concepts, situations, and relationships of mathematics.

Participants of class V elementary school in the state district of Darmaraja, the Sumedang district became a population in this research. Purposive Sampling is used for sampling. A sampling method known as "purposive sampling" tries to take sub-checks for a specific purpose by randomly selecting from a layer or region (Arikunto, 2013). The sample used is the students of class V SDN Darmaraja I and SDN Pataruman whose number of students each is 34 people. SDN Darmaraja I played as an experimental class and SDN Pataruman played as a control class.

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Table 2. Research Sample

No	Class	Manly	Female	Number of students
1	V	14	10	34
2	V	15	9	34

Source: Class Tearcher SD Negeri Darmaraja I and SD Negeri Pataruman

Methods to accumulate information in this study use measurable or quantitative data and data obtained from observation or qualitative. Pre- and post-test data acquisitions in experimental and control classes are used to compile quantitative data. Results of field records, the elevation of student responses to the AIR model, observation of teacher performance, observations of student activity of the experimental class, and controls are collected to become qualitative data. SPSS 17.0 software for windows is used as a tool for processing quantitative data and analyzing data. After the normality and homogeneity test, then the average difference test for quantitative data analysis. The Shapiro-Wilk test is used for the normality test, the Levene test for the homogeneity test, the t-test of 2 bundled samples, and the free-to-test of 2 samples are used for different averages. The NGain test is used to see the magnitude of the increase. Instead, descriptive analysis is used for qualitative data.

Before performing the pre-and post-test, the researchers performed a test of the legality and validity of the instruments in this study, to see if each resulting item is valid or not. There are 33 essays for validity tests, given to 30 learners. The validity test used SPSS 17.0 software for windows, and the results showed 22 valid questions and 11 invalid questions because the odds are greater or equal to 0,05. The conclusion the researchers were only 20 questions in this study. In addition, a reliability test was carried out with a result of 0,869 which showed that the tested instrument was very reliable.

RESULTS AND DISCUSSION

Initial meetings in both SDs were initially the same as pre-tests, then on the experimental class applied the AIR model, and the control class was done learning conventionally. After three meetings were treated, both SDs were given a posttest. Based on the learning results, normality, and homogeneity experiments are conducted to predict whether or not the data is distributed normally and homogeneously. The interpretation of the normality and homogeneity test in this study is that when the value of significance or probability > 0,05, then the data is distributed normally or homogeneous. Then when the probability value is < 0,05, the data is not normal or non-homogeneous. This test of normality and homogeneity in the test using the software SPSS statistics 17.0 for windows with the following results:

Table 3. Pre-test and Post-Test Experimental and Control Classes

	Class	Shapiro-Wilk		
		Statistic	*df*	*Sig.*
Mathematical Communication Skills	Pretest Experimental (AIR)	0,969	34	0,425
	Posttest Experimental (AIR)	0,964	34	0,314
	Pre-test Control (Conventional)	0,964	34	0,321
	Post-test Control (Conventional)	0,987	34	0,944

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It can be concluded that the data of the pre-test and post-test results of the experimental class are normally distributed, considering the value of the pretest probability = 0,425 > 0,05 and the probability of the post-test probability value = 0,314 > 0,05, as seen in Table 4, the results of posttest control class probability values = 0,944 > 0,05, whereas the probation of the control class Probability Value = 0,321 > 0.05. The survey showed that the control class was also distributed normally. Here are the results of the homogeneity test:

Table 4. Test of Homogeneity

Mathematical Communication Skills Test Result			
Levene Statistic	*df1*	*df2*	*Sig.*
2.722	1	66	.631

From table 4, the significance value of the test results can be the probability value = 0,631 > 0,05, which means data from both classes of variance are similar or homogeneous. Subsequently, the hypothesis test was carried out, the first assumption meant to see whether on the data processing material, the student experienced an increase in his mathematical communication ability or not after obtaining the AIR learning model. To know it is necessary to compare the initial state with the final state (pretest-posttest), since the data is 2 normal and homogeneous bound samples, then the test-t with two bound samples or pairing sample test is used to perform the test. The hypothesis tested was H_0 stating that in the experiment class, the pretest and post-test did not differ, and statin gated that between pre and post-test experiments classes offered. Test results show:

Table 5. Paired Samples Test Pre-Test and PostTest Experimental Classes Results

	Sig (2-tailed)	*Paired Samples Test*
Pretest-Posttest	0,000	There is difference

According to the table, the gain from the first hypothesis test has a 0,000 probability value listed in Table 5. H_1 is accepted and H_0 is rejected. The data suggest that the acquisition from the pre-test and post-test data of the experimental class are different. The NGain test values showed that the experimental class gained an improvement, the average experimental grade value after obtaining the AIR model was 0,4334 or 43,34%. The exposure shows that the ability to communicate mathematically has increased and is included in the middle level or level.

Table 6. Description NGain Mathematical Communication Skills in the Experimental Class.

Class	N	Average	Category
Experimental	34	0,4334	Medium

Later, the second hypothesis test was calculated to demonstrate the student's ability to mathematically communicate the experimental class and control its improvement differently. H_0 explains that the increase in both classes is not different, and H_1 stated that the improvement between the experimental class and the different control class is reviewed by how much the student's mathematical communication skills are increasing. The basis of decision-making in this study for the t-test of 2 free samples is that if the probability value is <0,05, then H_0 is rejected and H_1 is received, which means an increase in both different classes. Then when the probability value (2-tailed) > 0,05, H_0 is accepted and H_1 is rejected, which means the data processing material improvement of the mathematical

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communication skills of the students of the experimental class and the control class is not different. Based on the results of the SPSS 17.0 test for the t-test 2 free samples obtained the following data:

Table 7. Test Results in Independent Samples Test Posttest Experimental Class and Control Class

	Sig (2-tailed)	*Uji Independent Samples Test*
Posttest	0,000	There is an average difference.

Knowing the probability value = 0,000 < 0,05, based on decision-making in the independent test sample, means H_0 is rejected and H_1 is accepted. The average post-test results in both classes showed a difference in improvement among the students, which means that the increase in mathematical communication skills in the two classes is not the same:

Table 8. Rata-rata Hasil *Pretest* dan *Posttest* Kemampuan Komunikasi Matematis

Statistic	Experimental Classed		Control Classes	
	Pretest	*Posttest*	*Pretest*	*Posttest*
N	34	34	34	34
Average	21,42	54,82	25,23	34,73
Standard Deviation	7,99	16,61	10,48	13,84

Based on table 8, the pre-test average in the experimental class was 21,42 with a base score of 7,99. The pre-test average in the control class was 25,23 with a baking score of 10,48. Then the average postpost-testthe experimental class was 54,82 with a raw output of 10,81, while that was the post-test average in the control class of 34,73 with a Raw Output of 13,84. Data is clarified using the following NGain test results:

Table 9. Mathematical Communication Skills of Participants Experimental and Control Classes

Experimental			Control		
Interpreted	Frequency	Percentage	Interpreted	Frequency	Percentage
Down	-	0%	Down	6	17,7%
Stay	-	0%	Stay	2	5,9%
Low	7	20,6%	Low	23	67,6%
Medium	23	67,6%	Medium	3	8,8%
High	4	11,8%	High	-	0%
Number of	34	100%	Number of	34	100%
Average	0,4334		Average	0,1305	

Table 9 showed that there were 4 pupils (11,8%) in the experimental class whose mathematical communication skills increased high, 23 pupils (67,6%) moderate, and 7 pupils (20,6%) low. Including the average category, the average increase in the mathematical communication skills of the students on data processing material was 0,43. In contrast, for the control class, there were 3 pupils (8,8%) increased on average, 23 pupils (67,6%) moderate, and 2 pupils (17,7%) decreased. Included in the low category, the average escalation of the student's mathematical communication abilities for data processing material was 0,13%.

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Students of the experimental class, mathematical communication skills for data processing materials outperform the control class. The responses given by the students through the elevation of learning with the AIR model provide a realistic insight into the real improvement in the mathematical communication ability that occurs in the experimental class.

Table 10. **Criteria Results Angket Responses Participants to the AIR Learning Model**

Indicator	Percentage	Criteria
Response students' to AIR model	76,35%	Very Positive
Interest in learning with the AIR Learning Model.	79,23%	Very Positive
Difficulty learning data processing using the AIR learning model.	77,45%	Very Positive
Mathematical communication skills with the AIR learning model.	75,37%	Positive

Table 10 data is obtained from the elevation response of students on the AIR model. The table lists the first indicator of the resulting percentage of 76,35% with a very positive criterion. The second indicator of the resulting percentage of 79,23% against the criteria is very positive. The third indicator with a percentage of 77,45% with a very positive criterion and the fourth indicator resulted in a percentage of 73,37% with positive criteria.

Discussion

The learning process teaching in the experimental class that implements the AIR model in the beginning by focusing the hearing and vision of the students on the problems related to data processing is a problem that is thrown in the form of animated video. Then the students were divided into six groups with each group consisting of five to six heterogeneous students. Each group was allowed to discuss the animated videos that had been broadcast. When discussing, each group is given an LKPD that contains questions about data processing g that they must look for themselves until they can solve the problems that exist in the LKDP. After the discussion is completed, one group sold a presentation in front of the class, and the other group pays attention and asks and gives advice to the group that presents. Participants then conclude the information they have learned. During the learning process, some learners still find it difficult to connect images or diagrams represented by mathematical symbols, but they still try to solve problems and follow instructions accurately.

Experimental classes and control classes of mathematical communication skills at the beginning of the test were classified as low. The pre-test results in the experimental class were very low, while the data processing material was already provided by the teacher. Inappropriate learning approaches to students in the classroom may affect this. In mathematics subjects teachers always teach in the conventional way of lectures. Participants are not allowed to argue or ask about subjects they do not understand. This means that students are unable to read and process the information on the tables or diagrams presented. In addition to lectures, teachers can implement other learning models so that students understand, understand and be able to play an active role at the time of learning.

The learning model for elementary school students adapts to the materials and levels of education to be taught (Isrok'atun & Tiurlina, 2016). One of them is the air model. This AIR model is part of a cooperative type learning model whose learning process is discussed. AIR learning paradigm should help learners communicate mathematically in studying data processing. Through group discussions,

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students can also share information and knowledge (Nihaya et al., 2022).

Enhanced mathematical communication capabilities in this study use three indicator approaches, namely: 1) expressing everyday events in the language of mathematics, 2) connecting real objects, diagrams, and graphs into mathematic ideas, and 3) explaining concepts, circumstances, or solutions of maths by writing maths in the form of graphs or using the language itself (Hendriana, 2018). Measurement of the level of mathematical communication skills of the students is measured with the provision of the test (pretest-posttest) that is about the essay with the data processing materials taught.

The results of the average difference test that has been carried out in both the experimental class and the control class show a difference. This can be seen from the results of the average difference test of 0,000 <0,05. The average pre-test result in the experimental class was 21,42 and the control class was 25,23. while for the post-test average results in the experimental class was 54.82 and the control class was 34,73. These results indicate an increase in both classes. However, the improvement in the experimental class was superior to that of the control class.

According to the results of the post-test, in the first experimental class, the indicator increased by 21,8%, while in the control class, the increase was 8,08%. In the experimental class, the second indicator rose by 47,9%, while in the control class increased by 26,8%. A 72,6% increase occurred in the experimental class on the third indicator, compared with a 52,5% increase in the control class. This proves that the experimental class outperforms the control class in achieving indicators of mathematical communication ability. Students in the experimental class seem to have a better understanding of how to convey mathematical ideas through symbols, diagrams, or writing languages than students in the control class.

Acquisition of pre-test and post-test mathematical communication skills in either experimental class or control class, it can be concluded that many students are less than their maximum mathematics communication skills. This problem is caused by several factors, one of which is an obstacle to the implementation of learning. These barriers have nothing to do with the students and the facilities in the school. The concentration of students in accepting learning is still less. Some students disturb their friends and often allow them to go to the toilet. In addition, in delivering opinions, the student is not confident, and the student's point of view on mathematical subjects looks bad. Then the teaching and attention of teachers is also a factor in the success of the students.

The increased desire of students to learn can be demonstrated by increased mathematical communication skills. Mathematical communication abilities increased higher in experimental classes with AIR models compared to control classes that implemented conventional learning. Included in the middle level, the average mathematical communication ability increased by 43,34% in the experimental class, while the average control class improved by 13,06% in the lower category. The results showed that the student's mathematical communication skills increased differently in both classes.

CONCLUSIONS AND RECOMENDATIONS

According to the data of the acquisition of the lift response on the AIR model and both the results of the hypothesis test, it can be concluded that on the data error material implemented through the learning model AIR, the student experienced improvements in mathematical communication skills in the experimental class and there was a difference in the amount of improvement in the mathematic communication skills of the student between the experiment and control class. Both results show that the probability value = 0,000 < 0,05. The average mathematical communication ability of the experiment was 43,34% higher than the average increase in the control class of 13,06%. Increases in the experiment class were categorized as moderate, while improvements in the control class were classified as low.

Researchers recommend teachers to be able to implement the AIR model in mathematics learning because students are very enthusiastic during the learning process with the AIR model. Then other researchers can apply the AIR model with different concepts and on different materials so that it can be used as a comparison. This research can also be used as a reference for related research.

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