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Development of Mathematics E-Book on Pythagorean Theorem Material

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ABSTRACT

Penelitian ini bertujuan untuk mengetahui respon dan efek potensial dari penggunaan e-book matematika materi teorema Pythagoras. Metode yang digunakan pada pengembangan e-book ini yaitu ADDIE. Data penelitian diperoleh melalui angket respon siswa, dan tes hasil belajar siswa. Subjek yang digunakan sebanyak 15 orang siswa kelas VIII SMP Negeri 3 Mesuji Raya, Kab. Ogan Komering Ilir, Sumatera Selatan. Berdasarkan hasil analisis data diperoleh hasil bahwa kriteria respon siswa terhadap kepraktisan penggunaan e-book "Sangat Praktis" dengan rata-rata presentase 86,22%. Sedangkan aspek efek potensial dinyatakan memiliki "efek potensial" dengan rata-rata presentase sebesar 86,66% dari tes hasil belajar siswa. Dengan demikian dapat disimpulkan E-book matematika materi teorema Pythagoras layak digunakan untuk siswa kelas VIII dan dapat dikembangkan pada materi yang lain.

This study aims to determine the response and potential effects of using a mathematics e-book on the Pythagorean theorem material. The method used in the development of this ebook is ADDIE. The research data was obtained through student response questionnaires, and student learning outcomes test. The subjects used were 15 grade VIII students of SMP Negeri 3 Mesuji Raya, Kab. Ogan Komering Ilir, South Sumatra. Based on the results of data analysis, student responses about practicality obtained the criteria of "very practical" with an average percentage of 86.22%. While the potential influence aspect is stated to have "potential influence" with an average percentage of 86.66% of the student learning outcomes test. The Pythagorean theorem mathematics e-book is suitable for students to use and can be developed on other materials.

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INTRODUCTION

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation and state (UU Law No. RI No. 20 of 2003). In today's very rapid technological developments in the world of education to create innovations in the development of teaching tools. One of the branches of science that has an important role in the development of science and technology is mathematics. According to Hobri (Santi et al., 2015) mathematics as a basic science plays a very important role in the development of science and technology, because mathematics is a means of thinking to develop reasoning, logical, systematic, and critical thinking.

One of the successes of education depends on the learning tools used during the learning process. One of the learning tools is teaching materials. According to Pannen (Bayani, 2019) teaching materials are materials or subject matter used by teachers and students in the learning process that are arranged systematically. Meanwhile, according to Saputra & Salim (2020) teaching materials are all forms of materials used to assist teachers in carrying out teaching and learning activities in the class. Furthermore, according to Herawan and Utami (Nuryati et al., 2021) teaching materials contain knowledge, skills, and include attitudes that must be understood by students in order to

achieve predetermined competency standards. One of the teaching materials is books. Books are an unlimited source of knowledge and one of the teaching resources used in learning (Darlen et al., 2015).

In this era of globalization, it is undeniable that there are still many teachers who have not mastered information technology (in terms of learning media) to the fullest, even though this can make it easier for teachers to deliver material or information to students (Puspitarini & Hanif, 2019). One of the teaching materials that utilize technology is electronic books or e-books, which are digital versions of books which generally consist of a collection of paper containing writing and pictures. According to Subiyantoro (Mentari et al., 2018) that e-books are the evolution of printed books. Meanwhile, according to Prabowo & Heriyanto (2013) e-book is a digital form of a book that contains certain information. E-books can be interpreted as learning materials or facilities that are specially and systematically arranged and designed which contain a series of learning activities to achieve the expected learning objectives according to the level of complexity (Bayani, 2019). According James Ohene-Djan & Fernandes (2003) the e-book contains a network of digital information units consisting of text, video, animation, sound, and questions arranged in the form of a flash animation visualization in a program. The simplest e-book is an e-book which simply transfers a conventional book or printed book into an electronic form that only contains text and pictures. One of the teaching materials that have been used is electronic school book (ESB) which is easy to obtain. Based on the observations of the researchers, ESB has the advantage that it contains a lot of material, questions and projects, is equipped with pictures, is easily accessed and obtained via the internet, while the drawbacks of ESB are especially in the material for the Pythagorean theorem namely the scope of the explanation of the material is small, there are too many questions and projects, and only contains monotonous writing and pictures, making it difficult for students to study on their own and causing students to sometimes feel bored. For this reason, it is necessary to develop an interesting teaching material, namely an interactive mathematics e-book for students that contains writing, text, images, videos and reference link sources, which can help generate interest in reading and students' motivation to learn. E-books are considered effective and efficient enough to be used in the learning process in the classroom, are designed to be very attractive and flexible (not rigid) and published in digital form that can be read via a computer, laptop, or smartphone (Anggraini, 2020).

From the results of interviews with several mathematics teachers, information was obtained that learning is currently being done online. There are still very limited books in school libraries as learning materials and references, therefore e-books are very much needed in learning, especially in the current pandemic situation. The advantages of this e-book are that there are learning media such as animated pictures and learning videos, the goal is that students can easily understand the material by seeing and hearing learning videos, e-books are equipped with material links to access material on the website. Because e-books are designed to be flexible and according to needs, e-books can be easily used in the online learning process or distance learning. In addition, when studying the Pythagorean theorem material, students are expected to be able to understand the concept of solving Pythagorean theorem problems because it is one of the mathematical materials that will be linked to other materials such as flat shapes and spatial figures. In fact, sometimes students still often have difficulty understanding the concept of the Pythagorean theorem, students still find it difficult to understand the relationship between the hypotenuse and the two right angles so that students tend to only memorize the Pythagorean theorem formula, this condition can be overcome by using teaching materials and learning media (Putra, 2020).

Previously, many researches on the development of e-books had been developed, only the differences or novelties in the material, such as the research conducted by Bayani (2019) with the title "Development of Problem-Based Mathematics E-Books on Cube and Block Materials for SMP/MTS Class VIII". Furthermore, research conducted by Aspriyani dan Suzana (2020) with the research title "Development of Interactive E-modules of Circular Equation Materials Based on Realistic Mathematics Education with the Assistance of Geogebra", research by Fitrianna et al. (2021) with the title "Development of an Inductive Learning-Based Interactive E-Book Model to Practice Algebraic Reasoning Skills for Junior High School Students". The advantages of the e-book that will be developed are adding other material, namely the Pythagorean theorem, the contents of the e-book will be accompanied by text, images, material links and videos so that students can easily understand the material, and expand the distribution of e-books by utilizing internet media so that students and other readers easily to get it as a reference source.

Based on the background and problems above, the formulation of the problem in this research is as follows: How are the results of developing a mathematics e-book on the Pythagorean theorem material in terms of validity, practicality, and potential effects?

Validity is the feasibility of a product based on content components that are interconnected, consistent and relevant (Siswono, 2019). Practical if there is ease in using the product and it can be used repeatedly as needed (Smeda et al., 2014). According to Putra & Saputra (2018) potential effects are aspects of effects on users or users based on their experience of feeling potential effects which in research are the process and results of research in accordance with the expected effectiveness.

METHOD

The research method used in this research is research and development (R&D). According to Rayanto (2020) development research is a different type of research from educational research because the purpose of development is to produce products based on field test findings which are then revised. The procedure used in this research is (R&D) referring to the ADDIE model (analysis, design, development, implementation, and evaluation). According to Branch (2009) explains that ADDIE is a product development paradigm which is a development model. The product testing site was held at SMP Negeri 3 Mesuji Raya, which has the address at Gedung Rejo Village, Mesuji Raya District, Ogan Komering Ilir Regency, South Sumatera Province 2020/2021 academic year. The object of this research is a mathematics e-book on the Pythagorean theorem material. The subjects in this study were 15 students of class VIII.

In this study, the data collection technique used was interviews. Interview is a data collection technique if the researcher wants to conduct a preliminary study to find the problem that must be investigated (Sugiyono, 2016), validation sheets, questionnaires (questionnaires), student tests to determine the resulting product to be said to be feasible, valid, practical and has potential effectiveness. Data validity technique according to Moleong (Ibrahim, 2018). There are four criteria for the validity of the data in the study, namely the degree of trustworthiness, transferability, dependence and certainty. The data analysis technique in this research is using descriptive analysis techniques that describe the results of product development in the form of e-book teaching materials. Data analysis is generated by describing the characteristics of the data on each variable, validation test, practicality test and effectiveness test. The following are the criteria for assessing validity and practicality.

Table 1. Criteria for interpretation of validation and practical scores

Quality Score	Eligibility Criteria
$85\% - 100\%$	Very Valid
$70\% - 85\%$	Valid
$50\% - 70\%$	Less Valid
$0\% - 50\%$	Very Invalid

Source: Nesri & Kristanto (2020)

Quality Score	Eligibility Criteria
$81\% - 100\%$	Very Practical
$61\% - 80\%$	Practical
$41\% - 60\%$	Less Practical
$21\% - 40\%$	Not Practical
$0\% - 20\%$	Very Impractical

Source: Modifikasi dari Riduwan & Akdon (2013).

Furthermore, to find a valid and practical percentage value, the following formula can be used:

$$Presentase = \frac{Total\ score\ obtained}{Highest\ Total\ Score} \times 100\%$$

Source: Modification of Riduwan & Akdon (2013).

While the formula used to calculate the potential effect is as follows:

$$P = \frac{f}{N} \times 100\%$$

Information:
f = Number of students who pass the minimum score
N = Number of students
P = Percentage number
Source: Iqbal et al. (2019)

RESEARCH RESULT

The purpose of this research is to produce a mathematical e-book on the material of the Pythagorean theorem which is valid, practical and has potential effects. The trial was carried out on June 22-25, 2021. The subjects of this research were class VIII SMP Negeri 3 Mesuji Raya, Kab. Ogan Komering Ilir, South Sumatra as many as 15 students. The procedure or stages used are the ADDIE stages, namely the analysis stage, design Stage, development stage, implementation evaluation stage (Branch, 2009). The description of the research phase is as follows.

Analysis

At the analysis stage, information was obtained that the mathematics learning system at SMP Negeri 3 Mesuji Raya was good, it's just that educators often have difficulty understanding technology such as using computers and laptops to teach online. Educators still have difficulty developing electronic teaching materials to attract students' interest and motivation in learning, such as teachers still using printed books that are photographed as teaching materials and giving assignments during online learning so that students continue to study from home, and the limited number of books available in the classroom School library.

In addition, in the material of the Pythagorean theorem for even semester VIII students still often have difficulty understanding concepts to solve problems related to the Pythagorean theorem. Students still often have difficulty in understanding the relationship between the hypotenuse and the two right angles, so students tend to only memorize the Pythagorean theorem formula.

1. Design

After the analysis stage, the design stage is carried out on the e-book. At this stage there are several things that are done, namely the selection of materials, syllabus, making lesson plans (RPP), the instruments to be used and product design or product design assisted by Flipbook PDF Professional.

2. Development

In the development stage, the researcher develops an e-book according to the design that has been made. The initial media used for making e-books was Microsoft Word software. Then the results are made in the form of a PDF file so that it can be input (confort) into the Flipbook PDF Professional application where images and videos of learning materials can be inserted. Figure 1 and Figure 2 are the results of the development stage.

Figure 1. E-book start page display

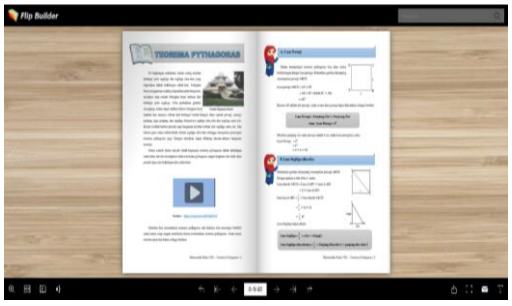
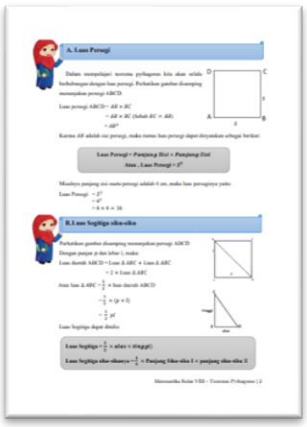
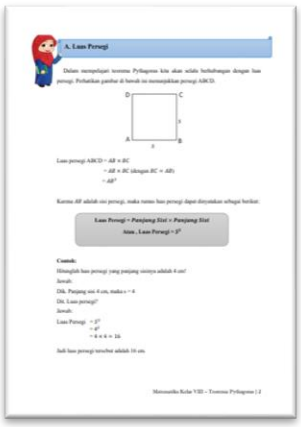
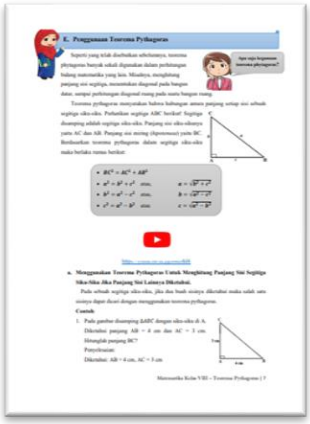
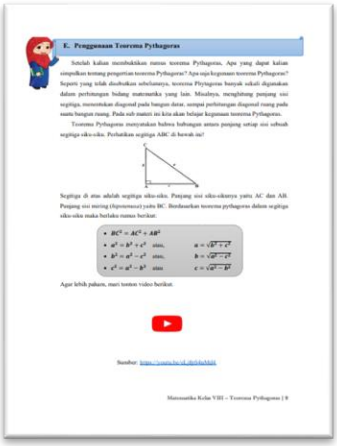
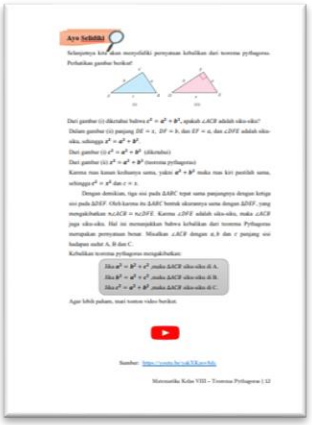
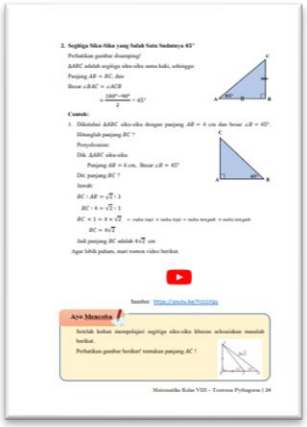
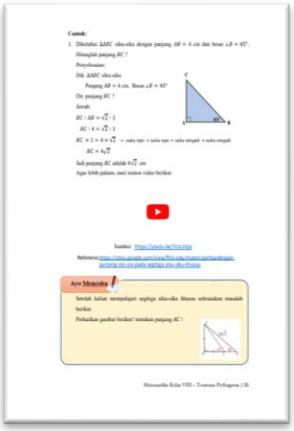


Figure 2. E-book content page display

After making the e-book, the next step is product validation by experts (expert review), namely two lecturers and one mathematics teacher. Product validation aims to see the feasibility of the product being developed. The product is said to be suitable for use if the validation results of each component show a minimum category of "valid" after product improvements have been made according to suggestion (Khomsiatun & Retnawati, 2015). Table 2 is the result of the validation of the research product.

Table 2. Product development revision

Validator comments	Before revision	After revision
The image should not always be placed on the right so that it looks more attractive.		
Illustrations or animations should not be too large, because they will interfere with the explanation or question writing.		
The color in the picture if there is a difference then give a different colors.		

Validator comments	Before revision	After revision
The color in the picture if there is a difference then give a different colors.		
Add website links related to the material for additional insight (if necessary).		
		

After the product is revised according to the suggestions, the validator fills out a validation questionnaire sheet. Based on the validation results, the next step is to calculate the average score given by the validator and calculate the percentage score of the product. The average score obtained is presented in Table 3.

Table 3. Score of validation

No.	Name validator	Average score	Results
1.	Validator 1	90.66%	Valid & worth using.
2.	Validator 2	92.66%	ACC, the e-book is worth trying out.
3.	Validator 3	91.33%	Valid & fulfills the principle.
	Average score	91.55	

Based on the results of the validation that has been carried out by experts or experts, an average overall percentage score of 91.55% is obtained, then the validity is obtained with the "Very Valid" criteria and is feasible in trial to prospective users. Before the researchers conducted field trials, the researchers conducted a one-to-one test on 3 students with different abilities, then students were given comment sheets or suggestions to assess the product. The results of student comments or input are revised as needed.

3. Implementation

The implementation phase has two stages, namely the small-scale trial (small group) and the large-scale trial stage. The small-scale trial phase was carried out to see the level of practicality of the product that had been developed by the researcher. The trial was conducted on 6 eighth grade students of SMP Negeri 3 Mesuji Raya, the selection of students was carried out randomly, assisted by a mathematics teacher at SMP Negeri 3 Mesuji Raya. At the small-scale trial stage, online learning was carried out through whatsapp groups. Table 4 is the result of a student response questionnaire to measure the practicality of the product.

Table 4. Results of practical questionnaire values for small-scale trial student responses (small group)

No.	Sample	Score obtained	Presentase
1.	S1	72	96%
2.	S2	64	85.33%
3.	S3	66	88%
4.	S4	60	80%
5.	S5	66	88%
6.	S6	60	80%
	Amount	388	86.22%

Based on Table 4, the overall average percentage score is 86.22% (from 6 respondents), so that it is included in the "Very Practical" criteria. The practicality of the product is reviewed from the results of the assessment sheet by practitioners with a minimum of good criteria based on the results of the implementation of product trials if the percentage is more than 80% (Bukhori, 2018).

After the product was tested in small groups and declared practical, then a large-scale trial (Field Test) was carried out. The aim is to see and find out the potential effects of the products developed by researchers through student learning outcomes tests. The criteria for potential effects (effective) if the product developed and then tested can improve problem solving abilities in students (Kawiyah, 2015). At this trial stage, two meetings were held in one class, namely VIII which consisted of 15 students. In the process of large-scale trials carried out by online learning. The following are the results of student learning tests for the Pythagorean theorem material in class VIII A of SMP Negeri 3 Mesuji Raya which are presented in Table 5.

Table 5. Student learning test results

No.	Name	Result						Total score	Description
		1	2	3	4	5	6		
	Score	15	15	15	15	20	20	100	
1.	AR	15	15	15	15	10	20	90	T
2.	AS	13	15	0	15	20	15	78	T
3.	AN	15	0	15	15	20	20	85	T
4.	ASD	15	0	10	15	0	20	60	TT
5.	DA	15	15	10	15	20	20	95	T
6.	EA	15	15	10	15	20	20	95	T
7.	FW	15	0	15	15	0	20	65	TT
8.	HN	15	15	15	15	0	20	80	T
9.	IA	15	15	15	15	20	20	100	T

No.	Name	Result						Total score	Description
		1	2	3	4	5	6		
	Score	15	15	15	15	20	20	100	
10.	MF	15	15	5	15	0	20	70	T
11.	ME	15	15	15	15	20	20	100	T
12.	RD	15	15	5	13	20	20	83	T
13.	S	15	15	15	15	0	15	75	T
14.	SW	15	15	15	15	20	20	100	T
15.	VO	15	10	15	0	20	20	80	T

Description: T = Complete TT = Not complete

Based on Table 5, the overall average score of 86.66% is obtained, with the percentage criterion, namely if the percentage of student learning test results after using the mathematics e-book achieves learning completeness or classical at least 80% of students according to the passing grade criteria, then e -math books are said to have a "potential effect" (Siswono, 2019). Thus, from the assessment data obtained, it can be stated that the developed mathematics e-book has a potential effect.

4. Evaluation

The final stage in the development of this e-book is to evaluate the e-book that has been developed based on student assessments from the implementation stage. When using e-books, class VIII students are very interested because it helps in the learning process. Their responses were also good when using this math e-book, as well as math teachers who felt very helpful with this math e-book because apart from the material there were also learning videos that explained the material. In terms of material and media it is good, but there are still obstacles experienced when using e-books, for example images that are not clear and slow in playing video material when the internet network is weak.

DISCUSSION

The development in this research has produced a product in the form of teaching materials, namely an e-book of mathematics on the Pythagorean theorem material. This teaching material was developed in accordance with the aim of helping students understand the concept of the Pythagorean theorem and its application. The developed mathematics e-book meets the characteristics of self instructional which refers to being able to make learning independently; Self Contained in which the teaching materials that are complete and intact; stand alone, which is not dependent on other teaching materials; adaptive, which has high adaptability; and user friendly, which denotes by the information provided is useful and friendly in its use, including convenience and according to needs (Pinahayu et al., 2018). This mathematics e-book consists of 50 pages, which contains the front page (cover, preface, table of contents), information page (concept map, basic competence and learning objectives, history of the Pythagorean theorem), content page (material, summary, sample questions, formative test), and the back page (glossary, bibliography, about the author, back cover). The advantages of the developed e-book are that the contents of the e-book are accompanied by text, images, material links and videos so that students can easily understand the material. The e-book is made in pdf, exe, and html formats, so that the e-book is easy to use. This is in line with Ruddamayanti (2019) a good e-book, namely an e-book that is flexible and not rigid, provides convenience for users and can be accessed in various ways.

The research and development of this mathematics e-book has three objectives, namely to determine the validity, practicality and potential effects of the developed e-book. Based on research and development data, it was found that the mathematics e-book on the Pythagorean theorem material was declared very valid and feasible to use with an overall average score of 91.55% (Table 3), then obtained validity with the criteria "Very Valid" because it entered in the category of mean score 81% (Table 1). The result of product validity is an agreement on the validator's assessment in terms of the feasibility and content of the product (Amalia & Kustijono, 2019).

E-book mathematics on the Pythagorean theorem material is stated to be very practical. Based on the results of the student response questionnaires that have been obtained, the average overall percentage score is 86.22% (Table 4), so that the mathematics e-book on the Pythagorean theorem material is included in the "Very Practical"

criteria because it is included in the average category. mean value 81% (Table 1). A product is said to be practical if it is easy to use the product and can be used repeatedly according to user needs (Smeda et al., 2014). According to Haviz (2013) that the practicality of the product is determined from the results of the use assessment, the level of practicality can be seen from the explanations of those who argue that the learning material is easy to use, the product developed is said to be practical if (1) Practitioners state that the product that has been developed can be applied in the field, (2) The level of product implementation including the category is in the good category.

To find out the potential effect of e-books, the researchers conducted a test on student learning outcomes. Based on the results of tests that have been carried out on 15 students, 13 students who have completed the KKM in school are 70. There are 2 students who did not complete the results of student learning. Judging from the learning outcomes test, it was obtained a percentage value of 86.66% with the criteria of a "potential effect" on students after using e-books (Table 5). The product is said to have a potential (effective) effect if the percentage of student learning test results after using e-book teaching materials achieves learning completeness and classical at least 80% according to the KKM criteria that apply in schools (Siswono, 2019). The product developed is categorized as having a potential effect (effective) seen from the increase in value before and after being given the product in learning (Purwati et al., 2021).

Judging from the results of the study, there were findings during the study that there were 2 students who had difficulty answering questions so they did not reach the KKM. This is due to limited time in learning so that students are less thorough in answering questions. In addition, they still do not understand how to apply the Pythagorean theorem to plane figures so that they find it difficult to answer the questions. Another finding is that students only focus on exam questions, this is known through comments on student response questionnaires with the question "Are the questions in this material included in the exam questions later?".

From the results of the research and discussion, the researchers hereby conclude that the development of a mathematics e-book on the Pythagorean theorem material that has been developed based on the results of expert assessments, student responses, and student learning outcomes tests can be concluded that this e-book can be declared very valid, very practical and have a potential effect on students.

CONCLUSION

Based on the results of research and development of mathematics e-books on the Pythagorean theorem material using the ADDIE stages or model (analysis, design, development, implementation, and evaluation) it is categorized as valid, practical and has a potential effect on students or users. Based on the results of the analysis of the data obtained regarding the validity or feasibility of the e-book, the criteria of "Very Valid" were obtained with a percentage of 91.55%. The results of student responses about practicality obtained the "Very Practical" criteria with an average percentage of 86.22%. While the potential effect aspect is stated to have a "potential effect" with an average percentage of 86.66% of the student learning outcomes test. So after the mathematics e-book on the Pythagorean theorem material can be used in the learning process and can be used by the wider community and this mathematics e-book can be developed again on other materials.

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