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Development of Science Experimental Video: Process of Converting Salt Water to Fresh Water on Classification of Material and Its Change

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Abstract: This study aims to determine the validity and practicality of the video entitled Process of Converting Salt Water to Fresh Water on science subject. In the process of developing this video, STEM elements and critical thinking skills are included. The method used is development research which consists of three stages, namely preliminary research, prototyping stage, and assessment stage. This study used an instrument in the form of a questionnaire in the form of a validity sheet (26 questions), a practical sheet (18 questions), and an interview sheet (5 questions). The validity test was conducted on three education practitioners, while the practicality test was conducted on students at SMPN 2 Padang. The results of the experimental video validity test show very high validity with an average Kappa Momentum (k) value of 0.91. The results of the practicality test through one-to-one evaluation and small group evaluation have a practical value of 91% and 96%, respectively, with a very practical level of practicality. To find out students' interest in the developed video, interviews were carried out which were used as additional data. The results of the interviews obtained student responses to the developed videos, generally students stated that developed videos was very interesting. Also, it is expected that developed videos can help teachers to train students' critical thinking skills.

Keywords: Classification of Material and its Changes; Critical Thinking; Experiment Video; STEM.

Introduction

The increasing need for technology has changed the paradigm of 21st century education. Educational orientation must lead to development that exceeds cognitive abilities in order to produce students who are competitive in job competition (Ariyanto et al., 2020). This education contains skills in problem solving and critical thinking, innovation, collaboration, creative and effective communication for the future (Redhana, 2019). The attachment of technology and information media in the digital era of the 21st century cannot be separated so that teachers must improve their competencies in order to be able to adapt to very fast changes (Mardhiyah et al., 2021).

The result of Programme for International Student Assessment (PISA) 2018 in science showed that Indonesia position still below the average score, obtaining a score of 396, while the average for all countries is 489 (Schleicher, 2019). Thus, comprehensive efforts are still needed in order to improve students' thinking skills, for example in terms of critical thinking. The data shows that students' critical thinking skills in Indonesia are at a low level, for that it is necessary to identify the causes and find efforts to fix them (Tajudin & Chinnappan, 2016).

Natural science is the basic science to find out what is in nature. In the 2013 curriculum, science subjects are taught in an integrated manner, not separated between chemistry, physics, biology and are said to be integrated science. Integrated science is a subject that has several concepts that can contain themes with different fields of study. So that learning objectives can be achieved efficiently and effectively. In addition, media learning

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can also achieve learning objectives (Setyowati et al., 2013).

The use of media for learning helps students improve their understanding, creative, interesting and reliable data presentation, easy to interpret data, and get conclusions in information (Dadi et al., 2019). Learning media is a means that is used as a channel or liaison between educators and students to achieve the learning objectives that have been formulated so as to generate student interest. STEM is an interdisciplinary approach to learning. Through the STEM approach students can apply science, engineering, technology, and mathematics simultaneously. In a real context, the STEM approach can connect schools, the global community and the world of work (Reeve, 2013).

Prospective science teacher students must master the material and basic competencies regarding how to think in accordance with the scientific method, then integrate the subjects of chemistry, physics, and biology to students into one concept called integrated science, so that these competencies are met, critical thinking skills very needed (Kusumah, 2019). Critical thinking is a skill in reflective thinking to make decisions about what to believe, do and be responsible for (Ennis, 2011). For students who have good critical thinking skills, they are not easy to take for granted the information they get but they can also account for their opinions with logical reasons (Firdaus et al., 2019). The use of video media in delivering learning materials can attract students' attention to focus on learning (Widiarti et al., 2021).

It is expected that this experimental video will make it easier for students to receive lessons and help students learn independently and can train students' critical thinking skills. This experimental video is also equipped with elements of STEM (Science, Technology, Engineering, Mathematics) and critical thinking which aims to train students in solving problems and students' responses to video entitled Process of Converting Salt Water to Fresh Water that is included in Classification of Materials and Its Changes topic.

Method

This development research uses a research design that is the Plomp model. The Plomp model consists of three stages, namely preliminary research, prototyping stage, and assessment phase. The Plomp model research design was chosen because each step of its development can be adapted to the characteristics of the research or is flexible (Rochmad, 2012). The initial investigation stage was carried out with several analyzes, namely needs analysis, curriculum analysis, concept analysis, and student analysis. The needs analysis instrument is designed based on several questions in the form of a questionnaire, to find out the problems that exist in schools that require solutions to develop a product. The results of the needs analysis are as follows 1) The curriculum currently used in the Material Classification material and its changes is the 2013 curriculum, 2) The learning method used by the teacher in the material classification material and its changes only uses the lecture and discussion method, 3) The teacher agrees to the experimental video media during the learning process, 4) Media in the form of experimental videos that are equipped with a STEM approach and critical thinking are needed both in learning.

At the stage of forming the prototype, the design of the prototype is carried out through several formative evaluations. So as to produce the final prototype or also called the final product. The video validity test was carried out by education practitioners of FMIPA UNP, the video was tested for validity according to the characteristics that must exist in the learning video by giving a score for each aspect. Furthermore, processing of the scores obtained, using the Kappa Cohen formula as follows.

$$K = \frac{Po-Pe}{1-Pe} \quad (1)$$

Information:
K = indicates product validity
Po = Realized Proportion
Pe = Unrealized Proportion

After processing the kappa moment results obtained, then calculating the average kappa moment and interpreting the values obtained based on table 1.

Tabel 1. Validity Category

Interval (%)	Category
0.81 – 1.00	Very High
0.61 – 0.80	High
0.40 – 0.60	Currently
0.21 – 0.40	Low
0.01 – 0.20	Verry Low

The video practicality test was carried out on students one evaluation and small group evaluation. The video is tested for practicality so that a score is obtained, then to determine the practicality value, it is obtained from the following formula.

$$P = \frac{R}{SM}\ x\ 100\% \quad (2)$$

Information:
P = Practicality value
R = Score obtained
SM = Maximum score

After calculating the average for each practical aspect, then interpreting the values obtained in the practicality category according to Table 2.

Tabel 2. Practical Category

Interval (%)	Category
81 - 100	Very High
61 – 80	High
41 – 60	Currently
21 – 40	Low
0 – 20	Very Low

Result and Discussion

Result

At the initial investigation stage, several analyzes were carried out, namely needs analysis, curriculum analysis, student analysis, concept analysis. Needs analysis was conducted through observation and interviews to find out the difficulties faced by teachers and students during the teaching and learning process. Based on the results of an interview with one of the science teachers, information was obtained that in the learning process the teacher had implemented the 2013 curriculum and in the learning process the teacher used the lecture and discussion method on the Classification of Materials and Its Changes topic, especially on the separation of mixtures. In addition, limited time causes teachers to rarely carry out experimental activities. Curriculum analysis is carried out by discussing the curriculum used in schools such as discussing the Classification of Materials chapter and its Changes, especially regarding Mixed Separation, as well as learning activities carried out and used as the basis for making videos. The analysis of students was carried out by distributing questionnaires containing several questions regarding the students' needs for learning media in the form of experimental videos. Concept analysis is carried out so that it can be used as a reference in developing experimental videos based on a systematic presentation sequence.

Based on the results of the analysis above, it is used as a reference in developing experimental videos that are expected to overcome the problems faced by students. The video that was developed contains an experiment, namely the Process of Converting Salt Water to Fresh Water, namely by conducting a simple distillation mixture separation experiment, in which there are elements of STEM (Science, Technology, Engineering, Mathematics). The distribution of STEM elements in this video can be seen in Table 3. In addition, this developed video also contains several critical thinking questions that can train students' critical thinking skills. The critical thinking indicators in this video are according to (Ennis, 2011) which is used as a reference in making several critical thinking questions which can be seen in Table 4.

Table 3. STEM Elements

STEM Elements	Application on video
Science	This experiment was carried out in accordance with the science material for class VII SMP in the first semester regarding the process of separating mixtures, namely distillation.
Technology	For introduction, students will be introduced to a video via cellphone from the Youtube entitled "Can Seawater Desalination Technology Overcome the World Freshwater Crisis?"
Engineering	- Designing the first manufacturing process, making salt water to be distilled. - Designing the second process, making a place for the distillation process called a desalinator. - Designing the third process, testing the desalinator
Mathematics	- Measuring the amount of fresh water collected after the distillation process. - Comparing the average amount of water collected from different salt content

Table 4. Sample Questions with Critical Thinking Aspects

Critical Thinking Aspects	Critical Thinking Questions
Elementary clarification	How can people living in coastal areas exposed to saltwater seepage to get fresh water?
Basic support	What happens if the colored water is not heated first?
Advanced clarification	What happens if the distillation apparatus is not given a stone as a ballast?

At the prototype stage, after conducting an initial investigation, this video was developed to produce an initial prototype or also known as prototype I. Then, a formative evaluation was carried out in the form of self-evaluation to produce prototype II. There are 7 aspects in conducting this self-evaluation, where the seven aspects are the same as aspects of the validation assessment carried out by experts. The seven aspects are 1) Clarity of massage, 2) Stand alone, 3) User friendly, 4) Content representation, 5) Visualization with media, 6) Using high resolution quality, and 7) Can be used classically or individual (Riyana, 2007). The validity test phase was carried out to determine the level of validity carried out by experts through an assessment of the experimental video. The results of data analysis from the experimental video validity test can be seen in Table 5.

Products are categorized as valid according to the suggestions given by each expert review. The advice given by the first validator is the video section such as understanding or important concepts, don't just use sound. But it takes writing that appears on the screen to clarify what is conveyed. Before the video was revised, there was no text when explaining the definition of mixed separation, it can be seen in Figure 1. After the

revised video was edited by adding text to the definition of mixed separation, using Arial font with a blue background to make it clear, it can be seen in Figure 2.

Table 5. Validation Data Analysis Results

Rated aspect	Average (k)	Validity category
Clarity of Massage	0.96	Very High
Stand Alone	0.80	High
User Friendly	1.00	Very High
Content Representation	0.80	High
Visualization with media	0.92	Very High
Using high resolution	1.00	Very High
Can be used classically or individually	0.96	Very High
Aspects of Critical Thinking	0.87	Very High
STEM	0.98	Very High

Figure 1. Display Model of Adding Text to Important Concepts Before Revision

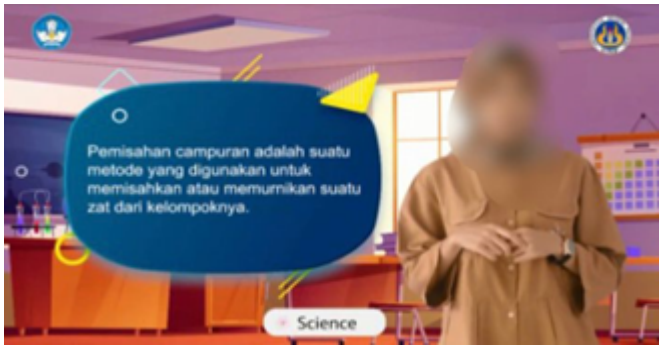

Figure 2. Display Model of Adding Text to Important Concepts After Revision

The second suggestion from the validator is that the images displayed in the sample separation mixture are too small in size. According to the advice given by the validator, increase the size of the image, so that it is clearly visible to students. The video has been revised according to the validator's suggestion, namely editing the video by increasing the image size. Before the video was revised the image looked small because it was glued to the box with a blue background which can be seen in Figure 3. After the video was revised the image size was enlarged without the blue background box which can be seen as in Figure 4.

Figure 3. Model View Magnification Image Sample Separation Mix Before Revision

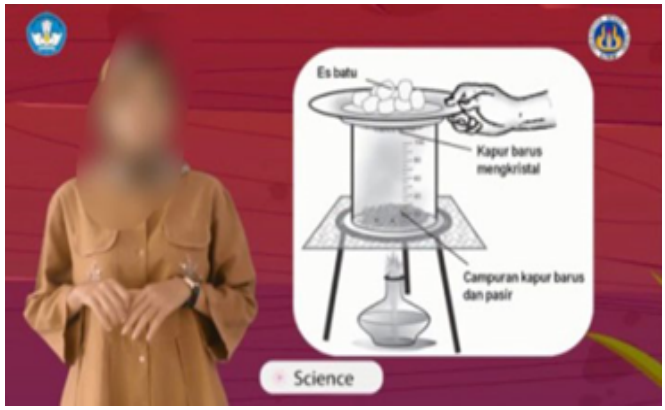

Figure 4. Model View Magnification Image Sample Separation Mix After Revision

The third suggestion of the validator is the image of the distillation mixture separation on the delivery of the material, the image is added. Editing is done by adding sample images after explaining the meaning of distillation. The video has been revised according to input from the validator. Before the video was revised, there were no sample images on the separation of the distillation mixture which can be seen in Figure 5. After the video was revised, editing was carried out on the video by adding an image of an example of separating the distillation mixture, in Figure 6.

Figure 5. Display Model Adding Distillation Images Before Revision

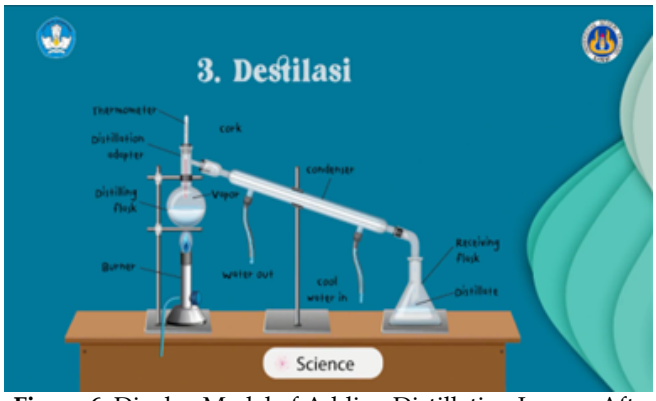

Figure 6. Display Model of Adding Distillation Images After Revision

The fourth suggestion of the validator is that when taking a hot measuring cup, a warning must be given on the video, that the measuring cup is hot. The addition of text to the description that the heat measuring cup has been edited. The video has been revised as per suggestions from the validator. Before the video was revised there was no warning information when holding a hot measuring cup, which can be seen in Figure 7. After the video was revised there was an addition of warning information when holding a hot measuring cup, which can be seen in Figure 8.

Figure 7. Display Model with Added Warning Notes Before Revision

Figure 8. Display Model with Added Warning After Revision

The fifth suggestion of the validator is that when drying the water, add a description of the length of the water drying duration, so that it is seen by the audience so that it is conveyed clearly. So the researchers made edits by adding a description text for the duration of drying water for 2 hours. The video has been revised as per suggestions from the validator. Before the video was revised, there was no information on how long the water took to dry, as shown in Figure 9. After the video was revised there was an additional 2 hours of time information, as shown in Figure 10.

Figure 9. Display Model Added Duration Description Before Revision

Figure 10. Display of Addition of Duration After Revision

When answering the first question, include pictures of real-world examples of the process in the community. So that students know real examples of the distillation process used by coastal communities. Before the video was revised there was no text when answering questions and there were no pictures in the answers to the first question, which can be seen in Figure 11. After the video was revised, text was added when answering questions and images were added to the first question, as in Figure 12.

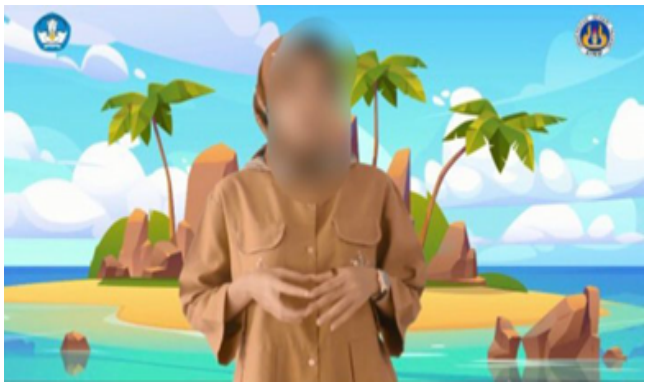

Figure 11. Display Model Adding Image Answers Before Revision

Figure 12. Display of Added Image of Answer Before Revision

After revising all the suggestions given by the validator, prototype III will be produced. The results of the validation that have been carried out prove that the video has a very high level of validity, so it is feasible to do it at the next stage, namely the one to one evaluation practicality test so as to produce a prototype IV. The results of the analysis obtained at the one-to-one evaluation practicality test stage can be seen in Table 6.

Table 6. One to one Anlysis Result

Rated aspect	Percentage (%)	Category
Ease of use	88.00	Very Practical
Attractiveness	88.00	Very Practical
Usefulness	98.00	Very Practical
Average of all components	91.00	Very Practical

Table 7. Small Group Analysis Result

Rated aspect	Percentage (%)	Category
Ease of use	94.00	Very Practical
Attractiveness	98.00	Very Practical
Usefulness	97.00	Very Practical
Average of all components	96.00	Very Practical

Table 8. Student Interview Analysis Results

Questions	Student responses		
	Student 1	Student 2	Student 3
Is this developed video able to make your child feel happy and comfortable when learning science? Explain it!	"Learning is fun because of ..."	"Could be, if the video shown ..."	"So it's fun because if..."
When asked this critical thinking question on developed videos, were you able to express your opinion? Explain it!	"Yes, I can, because in the video already..."	"Yes, if the question…"	"You can, if it's easy to understand because..."
Did your child become more interested in learning science after using developed videos? Explain it!	"I am interested, …"	"So I prefer to study science ..."	"Interested, because the video..."
Can using developed videos and the like make your child diligent in studying? Explain it!	"Yes, because if you only use books..."	"Depends on the video..."	"Yes, if the video..."
Can using learning videos like this make your child study more regularly outside of school hours? Explain it!	"Yes, because videos can be watched at any time..."	"Often because it can be watched through..."	"Yes, because it is accessible..."

Subsequently, a small group evaluation practical test was carried out to produce a V prototype which is also known as the final prototype (final product). The results of the analysis obtained through this small group trial, have a very practical level of 96%. It can be seen in Table 7. After the validity and practicality tests were carried out, three students were interviewed regarding the attractiveness response to the developed videos media that had been developed.

Discussion

The purpose of this study is to develop a STEM and Critical Thinking oriented science experiment video. This research is only limited by the criteria of validity and practicality of the product being developed. The following is a description of the validity of the study.

The Clarity of message aspect is the aspect of the assessment carried out by the validator on the video which is judged based on the ease of understanding and getting information after watching this developed video. The learning video has a message clarity aspect that is at

very high validity with a Kappa Moment (k) value of 0.96. With video media, students can capture information and store it in memory for long-term retention (Riyana, 2007). This learning video contains video elements including text, colors, images, sounds, with animation. Images can provide benefits because they support the clarity of image text (Octavyanti & Wulandari, 2021).

The stand-alone aspect is an assessment aspect that is assessed based on whether the product produced can stand alone so that it does not depend on other teaching materials. The results of the analysis obtained on the stand-alone aspect has a high level of validity with an average Kappa Moment value (k) of 0.80. This proves that the video developed has covered the content of the material to be achieved and does not have to be used simultaneously with other teaching materials. Agree with research (Usman & Husnan, 2020) which states that learning media in the form of videos can be used without using other teaching materials.

The User-friendly aspect (easy to use) is the aspect of the assessment carried out by the validator on the experimental video which is assessed based on the use of diction in the video according to the understanding of students and is communicative. The product with Kappa Moment (k) of 1 is the product with the highest validity. This proves that the product has met the user-friendly aspect, where the use of words and language is communicative so that it can provide understanding to students.

The content representation aspect is the aspect of the assessment carried out by the validator on the experimental video which is assessed based on the accuracy in delivering the material. The video has high validity with an average Kappa Moment (k) of 0.80. Related to the characteristics of the material, the selection of relevant media according to the material (Risky, 2019).

The visualization aspect with the media is the aspect of the assessment carried out by the validator on the developed videos which is assessed based on the video display developed from a visual (vision) perspective. It has a very high level of validity, and the average value of the Kappa Moment (k) is 0.92. The developed video has an attractive appearance. Therefore, the attractiveness of learning media can increase students' enthusiasm for learning. So that it will become a learning stimulus tool for students so as to arouse curiosity and student learning motivation, which in the end the learning objectives are achieved maximally (Sukarini & Manuaba, 2021). According to (Oka, 2018) states that dynamic material is very effectively delivered using media that is visualized through video. So, this can help teachers in the delivery of learning materials.

The aspect of using a high resolution is the aspect of the assessment carried out by the validator on developed videos assessed based on digital technology that is currently developing, so that it can display videos with good and clear quality. It has very high validity and the average Kappa Moment value (k) is 1.

Aspects of the use of videos can be used individually or classically based on the use of videos individually or collectively (classically) by students. So that the video can be used by individuals for independent study both at home and at school. The results of the assessment analysis by the three validators on aspects that can be used individually or classically have very high validity with an average Kappa Moment (k) value of 0.96. So that proves developed videos can be used individually and classically. This statement is reinforced by Wahyuningsih et al. (2022) which states that the use of learning videos can help students understand what they see, and control the video playback themselves. This means that videos can be used anytime and anywhere, both individually and collectively. Thus, the video media developed can be used by students outside school hours.

The critical thinking aspect is the aspect of the assessment carried out by the validator on the experimental video because the video contains elements of critical thinking, there is an assessment aspect of critical thinking. The results of the analysis obtained on this critical thinking aspect have very high validity and have an average Kappa Moment value (k) of 0.87. The use of video in learning can improve students' creative and critical thinking skills. Videos can present concrete learning objects and realistic messages (Kurniati et al., 2018). Thus, this video can train students' ability to think critically.

The STEM aspect is the assessment aspect carried out by the validator on the experimental video based on STEM elements, including developed videos equipped with science, technology, engineering, and mathematics components in it. The results of the analysis obtained from the validator's assessment of the experimental video have very high validity with an average Kappa Moment value (k) of 0.98. The existence of STEM elements in learning can increase students' interest in learning. According to Devi & Subali (2021) revealed that, from the results of the experiment the integration of STEM education in the learning process was able to increase the interest and achievement of students in learning science. Thus, the STEM aspect in the video can improve student achievement and interest in learning. Similar research shows that one of the reasons why this video has high practicality is because of its ease of use (Des Ramadini & Muttaqiin, 2023; Putri & Muttaqiin, 2023).

In the practical one-to-one evaluation stage, the video was tested for practicality on 3 participants. The

results obtained are different, such as students who have high, medium, and low levels of knowledge. This trial aims to produce a prototype IV. This stage is carried out after passing several stages, namely self-evaluation and validity testing carried out by experts (expert review). The one-on-one trial stage obtained a very practical level of practicality where the average Kappa Moment value (k) obtained was 91%. At this stage, there are no improvements that require re-taking the video or re-editing the video.

In the small group evaluation practicality test stage, the video was tested for practicality on 6 students. The trial was carried out in order to produce a final prototype, namely prototype V. This trial stage was carried out after passing through several stages, namely self evaluation, expert review, and one to one evaluation. Based on the analysis results obtained after conducting this small group evaluation practicality test, it was found that the practicality level was very practical, the average Kappa Moment (k) value was 96%. Through the results of the data obtained, it proves that experimental videos are very practical to use. At this stage, there are no improvements that require re-taking the video or re-editing the video.

After the video is developed in accordance with the development research procedure, it is up to the stage of validity and practicality. Interviews were conducted with students regarding their interest in developed videos media. In the aspect of feeling happy, students revealed that videos can make them happy and comfortable in learning. In the aspect of student interest, this developed videos media can attract the attention of students' learning. In the aspect of involvement, developed videos media can train students' critical thinking skills. In the aspect of being diligent in learning, this developed videos media can provide comfort to students and is diligent in learning, because developed videos media can be watched anytime and anywhere. Therefore, this developed videos media can give a pleasant impression to students so they don't feel bored when learning science and can make students study regularly because it can be played anytime and anywhere.

Conclusion

After conducting research, the results obtained are 1) Developed video which was validated by experts has a very high level of validity category, 2) Developed video media which was tested for practicality to students with a very practical level of practicality category, 3) Based on the results of interviews developed videos media can be interesting students' attention. Based on the result, the video is valid and practical to be used as a supplementary learning media in science classroom. The further study is needed to test the effectivity of the video.

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The contribution of the authors including Annisa Destrina: doing validation, investigation, formal analysis, writing the original draft, and so on; and Arief Muttaqiin: focus on methodology, supervision, and writing review.

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The authors declare no conflict of interest.

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