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Empowering Vocational Informatics Students with Android-Based Problem-Based Learning Media

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ABSTRACT

Technology is experiencing rapid development and is in line with the increasing need for adequate human resources (HR). There is a need for educators to prepare themselves to teach and produce high-quality individuals. However, many students are still not ready to enter the workforce. To prepare high-quality students, a good conceptual understanding is needed, and to achieve this, students must have strong learning motivation. One way to increase motivation is by using the Problem-Based Learning model and supported by Android-based learning media. The purpose of this research and development is to (1) Develop, (2) Test the feasibility, and (3) Determine the increase in student motivation in using Android-based learning media with a Problem-Based Learning model in Informatics subjects at vocational high schools that have been developed. The 4D model was chosen for this development, with stages including define, design, develop, and disseminate. The development result is an Android-based learning media called "Mepins" (Informatics Learning Media). The evaluation results obtained from material expert validation were 100% with very suitable criteria, the results from media expert validation were 81.09% with suitable criteria, the results from small-group development testing were 80.53% with suitable criteria, the results from large-group field testing were 86.32% with very suitable criteria, and the results from large-group motivation testing were 88.75% with very suitable criteria, with an N-Gain value of 0.54, which is interpreted as moderate. This indicates that implementing problem-based learning increases student motivation. Therefore, the media is considered suitable and can be used as a supporting learning media for Informatics subjects at vocational high schools.

I. INTRODUCTION

Technology is experiencing rapid development, and as a result, there is an increasing need for adequate human resources. Human resources reflect the quality of an individual, which is evident in their ability to work and their ability to carry out activities that have a positive impact. Outstanding individuals will bring about better technological advancements than what we have today.

To create high-quality individuals, educators need to prepare themselves to teach and educate in the framework of 21st-century learning, which is in line with the advancement of the Industrial Revolution 4.0 era [1], [2]. Schools play a role as a platform where educators gather to provide lessons and education to polish talents, resulting in high-quality individuals.

Vocational High Schools are educational institutions that have educators who are ready to polish individual talents to directly enter the workforce [3], [4]. The main goal of Vocational High Schools is to increase students' skills [5]. This is in line with the increase in human resources, which will eventually help and contribute to technological advancements. However, data from the Central Statistics Agency indicates that the most significant number of unemployed individuals are those who graduated from Vocational High Schools, reaching 9.6% of the total 7.9 million unemployed individuals in Indonesia. This emphasizes that although Vocational High Schools were created to produce outstanding individuals in the workforce, they still have shortcomings in preparing students who are fully skilled in the science and technology required when entering the workforce. Many obstacles cause students to be unprepared and lack skills, one of which is the lack of deep understanding of vocational basics [6], [7], [8], [9].

Each vocational field has a different area of expertise. In the field of Computer and Informatics Technology. One of the basic sciences that need to be mastered in this field is computer basics, which is found in Informatics subjects. Informatics subjects play a role in shaping students' skills in logical thinking, data analysis, and interpretation, which are required for literacy, numeracy, basic sciences, and modelling and simulation in the world of computing using technology [10]. The materials presented in Informatics subjects become the foundation for understanding higher-level materials. Because of the importance of this subject for basic understanding, students need to take it seriously. However, from the results of observational studies, interviews, and questionnaire distributions conducted at SMKN 1 Purwosari, SMKN 2 Singosari, and SMKN 5 Malang, it can be concluded that during the implementation of Informatics learning, students are still less motivated to learn this subject, resulting in weak Informatics basics.

In this study, interviews were conducted with students who had completed the Teaching Assistance Program at SMKN 5 Malang, SMKN 2 Singosari, and SMKN 1 Purwosari. For the questionnaire distribution, 30 students from SMKN 1 Purwosari and SMKN 2 Singosari who had taken Informatics subjects participated. The results obtained from the observation include: 1) The teaching methods used by teachers are still conventional or lecture-based; 2) The learning media used are mostly PowerPoint-based; 3) The teaching materials available in schools are limited; 4) Students still lack understanding and motivation in Informatics subjects.

Understanding concepts is a fundamental factor that influences learning outcomes, and students who have a strong understanding of concepts will achieve the best learning outcomes, and vice versa. To obtain a strong understanding of concepts, strong learning motivation is also needed from students [11], [12]. If students are motivated to learn, they will find the learning materials easy to understand, and the learning process will be more engaging. To increase student motivation, many learning methods can be used, one of which is the Problem-based learning approach [13], [14], [15], [16].

The Problem-Based Learning model makes students more creative in thinking and solving problems given at the beginning of the meeting [17]. In Problem-Based Learning, students are encouraged to combine new knowledge with what they already must solve real-world problems through group work. To increase the success rate of the Problem-Based Learning model, supporting learning media is also needed.

Learning media are tools that can be useful in learning activities to make it easier for students to understand learning materials and for materials to be easily conveyed to students. According to data from StatCounter Global Stats in 2023, the Android operating system on smartphones ranks first with a user percentage of 88.08% of all smartphone users in September 2023. From this data, it is estimated that almost all students use Android smartphones. This makes Android-based learning media a breakthrough in learning media and provides many conveniences in supporting better and more engaging learning.

Based on the explanation above, it can be concluded that students are still less motivated to learn Informatics subjects. From this, the author is interested in taking the thesis title "Development of Interactive Learning Media Based on Android with Problem-Based Learning to Increase Motivation of Informatics Students at Vocational High Schools". The learning media presented using Problem-Based Learning is expected to make students more enthusiastic and motivated to learn and understand learning concepts.

II. METHODS

The research model used by the researcher is the FourD (4D) model. The Four D (4D) research and development model is an abbreviation of Define, Design, Develop, and Dissemination developed by Thiagrajan, Dorothy S. Semmel and Melvyn I. Semmel.

A. Define

This stage determines the main problems faced in the learning process. It is followed by an analysis of student characteristics, considering several factors such as student motivation and experience during the Informatics learning process. The analysis of student characteristics is conducted through questionnaire distribution and informal interviews with students and teachers who teach Informatics subjects. The results of the student characteristic analysis are used as a reference for determining the choice of media and format used. The final stage of the defining phase is to determine the learning objectives.

B. Design

This stage involves selecting the media first, based on literature studies related to media development and learning models for Informatics subjects. Android was chosen as a suitable media for developing the material because it supports various media formats such as audio, video, and images, and according to observational results, students have Android smartphones. The format used to present Informatics material in the development of learning media is the Problem-Based Learning model. The design of the media is then planned.

C. Develop

In the development stage, the development of Android-based learning media with Problem-Based Learning for Informatics subjects is carried out. The developed learning media is then tested by experts to determine its feasibility. Material experts and media experts will validate the media to test its feasibility for use. The validation from experts is used as a revision or improvement of the developed media, and if it meets the requirements, it can proceed to the small-scale development test. After revisions from media and material experts, the learning media is tested on a small scale. The small-scale test aims to obtain the required data, which will be analyzed. Next, after revisions from the small-scale development test, a larger-scale field test is conducted.

D. Disseminate

In the dissemination stage, the conclusion is obtained regarding the feasibility of the developed learning media, which is obtained from the responses of students involved in the testing. The next step is to package the developed learning media by creating a user manual for the media so that it can be used by others. Finally, the dissemination stage involves publishing an article on the website of the LITE journal to disseminate the learning media.

The instruments used in the research and development include expert validation instruments, media expert instruments, small-scale development test instruments, field test instruments, and motivation learning instruments. These instruments are made using the Likert scale. The Likert scale criteria are shown in Table I

TABLE I. LIKERT SCALE

Results	Score
Very Good/Very Suitable/Very Interesting/Very Clear/Very Accurate/Very Appropriate	4
Good/Suitable/Interesting/Clear/Accurate/Appropriate	3
Less Good/Less Suitable/Less Interesting/Less Clear/Less Accurate/Less Appropriate	2
Not Good/Not Suitable/Not Interesting/Not Clear/Not Accurate/Not Appropriate	1

Next, the instrument will be distributed for testing. The validation test results are used to measure the quality of the media and materials. This validation test is conducted by 2 experts. The Material Expert Validation is then followed by distributing the instrument for small-scale development testing, which is tested by 10 students at SMKN 1 Purwosari, majoring in Computer and Informatics Engineering, who have taken Informatics subjects. Additionally, a large-scale field test is conducted by testing 30 students at SMKN 1 Purwosari, majoring in Computer and Informatics Engineering, who have taken Informatics subjects.

In this study, descriptive analysis techniques were chosen to analyze the obtained data. Descriptive analysis provides a description or presentation of the data by considering the mean, standard deviation, variance, maximum value, minimum value, data range, kurtosis, and skewness (asymmetry of distribution). In descriptive analysis, the data will be described in the form of mean values that are categorized into several categories.

Each category can be formulated by analyzing the scores obtained. The formula and category interpretation for the media data are as follows:

$$V = \frac{TSEV}{S-max} \; x \; 100\% \qquad (1)$$

TABLE II. CATEGORY INTERPRETATION OF MEDIA DATA

Percentage (%)	Category	Description
85,01 – 100	Very Valid	Can be used without revision
70,01 – 85,00	Valid	Can be used with minor revisions
50,01 – 70,00	Less Valid	Not recommended for use, major revisions needed
01,00 – 50,00	Not Valid	Cannot be used, total revision needed

The results obtained from the percentage values can be analyzed to obtain a conclusion on the feasibility of the media against the developed learning media. For the formula and category interpretation of the motivation, data are as follows.

$$P = \frac{TSE}{TSH} \; x \; 100\% \qquad (2)$$

TABLE III. CATEGORY INTERPRETATION OF MOTIVATION

Percentage (%)	Category
76 – 100	Very High
51-75	High
26-50	Low
0-25	Very low

On the other hand, the formula and category interpretation for the motivation increase data are as follows.

$$N - Gain = \frac{PostTest - PreTest}{Max.\ Score - Pretest}$$

TABLE IV. INTERPRETATION OF MOTIVATION INCREASE DATA

Percentage (%)	Category
N-Gain > 0,70	High
0,30 < N-Gain < 0,70	Medium
0,00 < N-Gain < 0,30	Low

The results obtained from the percentage values can be analyzed to obtain a conclusion on the increase in learning motivation towards the developed learning media.

III. RESULTS AND DISCUSSION

The result of the media development is a learning media based on Android called "Mepins", which stands for “Media Pembelajaran Informatika”. In this research and development of Mepins, the FourD (4D) development model was used. The FourD (4D) research and development model consists of 4 stages, namely Define, Design, Develop, and Disseminate. The explanation of the research and development results from each stage is as follows.

A. Define

This stage collected data using observation and interview methods to identify user problems. The researcher conducted observations on Informatics learning activities for Class X RPL students during a teaching assistantship at SMKN 1 Purwosari. Interviews were conducted with Informatics subject teachers at SMKN 1 Purwosari, Class X RPL students who were taking Informatics lessons at SMKN 1 Purwosari, Class XI RPL students who had taken Informatics lessons, fellow students who were conducting teaching assistantship at SMKN 2 Singosari, and SMKN 5 Malang who taught Informatics.

From the observations and interviews that have been conducted, an analysis of the obtained data was performed. The Computational Thinking learning element was chosen to be included as the main material to be used in the development of the media.

TABLE V. OBSERVATION RESULTS

Percentage	Location	Indicator
70% 71% 60%	SMKN 1 Purwosari SMKN 2 Singosari SMKN 5 Malang	Students feel that the availability of attractive learning materials in school is minimal.
75% 76% 60%	SMKN 1 Purwosari SMKN 2 Singosari SMKN 5 Malang	Students feel that they are not adequately assisted in understanding the material when learning using conventional media such as PowerPoint and Google Classroom.
80% 88% 80%	SMKN 1 Purwosari SMKN 2 Singosari SMKN 5 Malang	Students feel that they are not motivated to learn the material when learning uses conventional media such as PowerPoint and Google Classroom.
75% 82% 80%	SMKN 1 Purwosari SMKN 2 Singosari SMKN 5 Malang	Students feel that they have difficulty understanding Informatics subjects.
60% 82% 40%	SMKN 1 Purwosari SMKN 2 Singosari SMKN 5 Malang	Students feel that they have difficulty understanding Computational Thinking elements.

B. *Design*

The Mepins learning media was also adapted to the Problem-Based Learning model, which consists of 5 stages: 1) Directing students towards problem-solving; 2) Organizing students to learn; 3) Assisting independent and group investigation; 4) Developing and presenting work results and showcasing them; 5) Analyzing and evaluating the problem-solving process.

Next, a layout design for the application was created using Figma software. The design on Figma is in the form of wireframing or rough design, which aims to simplify the creation of the initial framework for the developed media. Figure 1 shows the design of the Mepins learning media.

C. *Develop*

This stage involves developing the media. The development of Mepins was carried out. The development of Mepins used several software, including Adobe Illustrator CC 2019 Pre-Activated, which was used to design assets and backgrounds, Figma, which was used to create the design of the UI/UX layout, WordPress, which was used to create the website, Website 2 Apk Builder, which was used to convert the website into an Android application, and Microsoft Word 2019, which was used to create materials. Table VII shows the specifications of the Mepins media. The result of the development of the Mepins learning media that has been created is shown in Figure 2 and Figure 3.

TABLE VI. MINIMUM SPECIFICATIONS

Specification	Description
Operating system	Android *Lollipop* (5.0)
RAM	2 GB
Internal memory capacity	100Mb
Resolution	400 x 800 px

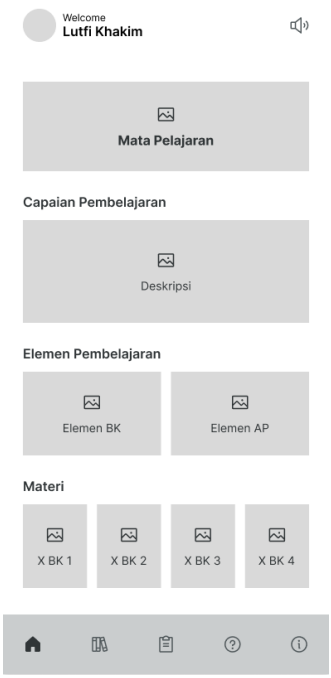

Fig 1. Mepins Wireframe Design

Fig 2. Initial Display of Mepins

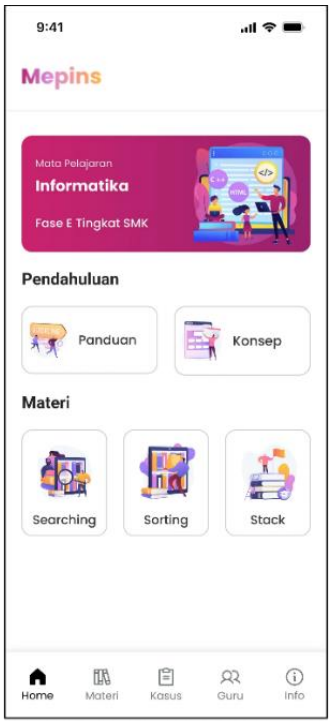

Fig 3. Home Display of Mepins

Next, the developed media will be validated first to be tested. The validation test results are used to measure the quality of the media and materials. This validation stage was conducted by 2 experts. The material expert validation was followed by a small group development test, which was tested on 10 students at SMKN 1 Purwosari, majoring in computer and informatics engineering, who had taken Informatics subjects, and a large group field test, which was tested on 30 students at SMKN 1 Purwosari, majoring in computer and informatics engineering, who had taken Informatics subjects. The description of the Mepins learning media testing is as follows.

1) Material Expert Validation

The quantitative data consisted of 21 items, divided into 2 aspects: the learning design aspect and the visual communication aspect. The results of the material expert validation test are presented in Table VIII.

TABLE VII. MATERIAL EXPERT VALIDATION RESULTS

Assessment Aspect	Assessment		V%	Description
	TSEV	S-max		
Learning Design	52	52	100,00	Very Valid
Visual Communication	32	32	100,00	Very Valid
Total	84	84		
Average			100,00	Very Valid

Based on the material expert validation assessment, a calculation result of 100.00% was obtained with very suitable criteria, so it can be used without revision according to the feasibility category shown in Table VIII. From the validation that has been done, the Mepins learning media is in line with the learning objectives, the language used in the media is easy to understand, and the media presented is attractive. This criterion is consistent with the results of previous research, indicating that this application can be used safely, guaranteeing its functionality and usability aspects, which support the benefits according to the plan in the next testing stage [18].

2) Media Expert Validation

The quantitative data consisted of 22 items, divided into 3 aspects: software engineering aspect, learning design aspect, and visual communication aspect. The results of the media expert validation test are presented in Table IX.

TABLE VIII. MEDIA EXPERT VALIDATION RESULTS

Assessment Aspect	Assessment		V%	Description
	TSEV	S-max		
Software Engineering	25	32	78,13	Valid
Learning Design	10	12	83,33	Valid
Visual Communication	36	44	81,82	Valid
Total	71	88		
Average			81,09	Valid

Based on the media expert validation assessment, a calculation result of 81.09% was obtained with suitable criteria, so it can be used with minor revisions according to the feasibility category shown in Table IX. Mepins are easy to operate, easy to understand, and function normally. Mepins also presents complete, detailed, clear, and easy-to-understand material. This criterion is consistent with the results of previous research, indicating that this application can be used safely, guaranteeing its functionality and usability aspects, which support the benefits according to the plan in the next testing stage [18].

3) Testing of Media (Small Group)

The small group development test was conducted with 10 students from the Computer and Informatics Engineering program at SMKN 1 Purwosari. The small group development test is useful for obtaining feedback from students about the application that was created.

TABLE IX. TEST RESULTS OF MEDIA (SMALL GROUP)

Assessment Aspect	Assessment		V%	Description
	TSEV	S-max		
Software Engineering	133	160	83,13	Valid
Learning Design	350	440	79,55	Valid
Visual Communication	221	280	78,93	Valid
Total	704	880		
Average			80,53	Valid

Based on the media development test assessment, a calculation result of 80.53% was obtained with suitable criteria. Mepins are easy to operate, easy to understand, and function normally. The media development test results on these 3 aspects, although the average score is obtained. Overall, it meets suitable criteria. This criterion is consistent with the results of previous research, indicating that this application can be used safely, guaranteeing its functionality and usability aspects, which support the benefits according to the plan in the next testing stage [18].

4) Testing of Media (Large Group)

The field testing of media was conducted with 30 students from the Computer and Informatics Engineering program at SMKN 1 Purwosari. This field testing aimed to test the feasibility of the media.

TABLE X. TEST RESULTS OF MEDIA (LARGE GROUP)

Assessment Aspect	Assessment		V%	Description
	TSEV	S-max		
Software Engineering	418	480	83,08	Very Valid
Learning Design	1128	1320	85,45	Very Valid
Visual Communication	726	840	86,43	Very Valid
Total	2272	2640		
Average			86,32	Very Valid

Based on the field testing, there was an increase in the results of each aspect, resulting in a significant increase in the validity criteria. The Software Engineering aspect obtained a score of 87.08%, making it the highest-scoring aspect with an increase of 3.95%. The high percentage score of the software engineering aspect is due to the ease of operating the application. The ease of access to the application makes users more interested in learning the available materials. Next, the Visual Communication aspect scored 86.43%, becoming the second-highest-scoring aspect with an increase of 7.5%. Learning media requires good visuals, clear and easy-to-read language, and simple grammar to understand. The Learning

Design aspect scored the lowest with a percentage of 85.45% and an increase of 5.9%. In the learning design aspect, there was an indicator with a statement that the presented material was in line with the learning objectives, scoring the lowest with a score of 79%. However, this low score can be improved by adjusting the learning objectives, preparing materials systematically, aligning materials with concepts, and preparing questions that match the material presentation [19], [20].

From the results of the field testing of media in these three aspects, an overall score of very suitable was obtained. This criterion is consistent with the results of previous research, indicating that this application is suitable for use and can guarantee its functionality and usability aspects, which support the benefits according to the plan in the next testing stage [18].

5) Testing of Motivation (Large Group)

The data on the level of student learning independence before using the WCode learning media is presented in Table XII.

TABLE XI. MOTIVATION RESULTS (PRE-TEST)

Assessment Aspect	Assessment		P%	Description
	TSE	TSH		
Attention	469	600	78,17	High
Relevance	455	600	75,83	High
Confidence	455	600	75,83	High
Satisfaction	428	600	71,33	High
Total	1807	2400		
Average			75,29	High

The data on the level of student motivation after using the Mepins learning media is presented in Table XIII.

TABLE XII. MOTIVATION RESULTS (POST-TEST)

Assessment Aspect	Assessment		P%	Description
	TSE	TSH		
Attention	540	600	90,00	Very High
Relevance	535	600	89,17	Very High
Confidence	522	600	87,00	Very High
Satisfaction	533	600	88,83	Very High
Total	2130	2400		
Average			88,75	Very High

"Based on the assessment of student motivation levels after using the Mepins learning media, the calculation results showed a score of 88.75% with a very high criterion, according to the category of student learning independence shown in Table XIII.

Furthermore, a normalized gain (N-Gain) test was conducted to measure the increase in motivation after using the media. The data on the increase in student motivation is presented in Table XIV.

TABLE XIII. MOTIVATION INCREASE RESULTS

Assessment Aspect	Assessment			Description
	Pre-Test	*Post Test*	*N-Gain*	
Attention	78,17	90,00	0,54	Medium
Relevance	75,83	89,17	0,55	Medium
Confidence	75,83	87,00	0,46	Medium
Satisfaction	71,33	88,83	0,61	Medium
Total	**75,29**	**88,75**	**0,54**	**Medium**

Based on the calculation of the increase in student motivation values. The values obtained for the attention aspect of students after using the media are a pre-test score of 78.17%, a post-test score of 90.00%, and when calculated using the N-Gain Hake formula (2002), the N-Gain value obtained is 0.54 with a moderate interpretation. This indicates that the media can increase student attention and by using learning media can increase and direct student attention, thereby generating interest and motivation to learn. The values obtained for the relevance aspect of students after using the media are a pre-test score of 75.83%, a post-test score of 89.17%, and when calculated using the N-Gain Hake formula (2002), the N-Gain value obtained is 0.55 with a moderate interpretation. The highest increase in N-Gain values was found in the relevance aspect. This is also supported by the presence of learning media. Creative and attractive media will make students more motivated and enthusiastic to continue learning. The values obtained for the confidence aspect of students after using the media are a pre-test score of 75.83%, a post-test score of 87.00%, and when calculated using the N-Gain Hake formula (2002), the N-Gain value obtained is 0.46 with a moderate interpretation. This indicates high student confidence in themselves when completing materials and questions. The values obtained for the satisfaction aspect of students after using the media are a pre-test score of 71.33%, a post-test score of 88.83%, and when calculated using the N-Gain Hake formula (2002), the N-Gain value obtained is 0.61 with a moderate interpretation. This indicates that the use of media can increase student satisfaction with lesson materials and interactive learning media can be used to create an interactive learning environment and increase student satisfaction.

Based on the overall data presented, the average pre-test score is 75.29, which indicates the level of learning motivation before using the Coopas learning media, and the average post-test score is 88.75 after using the Coopas learning media. Furthermore, the motivation field test scores for the pre-test and post-test were calculated to find the increase in motivation using the N-Gain formula, resulting in a value of 0.54. The N-Gain value of 0.54 obtained a moderate interpretation, which is within the range of 0.30 - 0.70, as shown in Table 3.11. With the results obtained, it can be concluded that there is an increase in motivation after using the Mepins learning media, which can increase student motivation, especially in Informatics subjects at SMK.

D. Disseminate

After revising the developed media, the conclusion is that the Mepins learning media is suitable for use. Next, a user manual for the Mepins learning media was created. The manual contains information about the application and the steps for

using the Mepins learning media. This manual assists new users in operating the Mepins learning media.

Fig. 1. Mepins Guidebook

Furthermore, an article was written based on the development of this learning media to be uploaded to the Lite journal website. The purpose of this upload is to disseminate the Mepins learning media, with the hope that it can contribute to the field of education in Indonesia.

IV. Conclusion

Based on the given data, it can be concluded that: 1) The learning media developed is named "Mepins". Mepins is developed as an Android application; 2) The Mepins learning media has passed several feasibility testing stages, including material expert validation with a score of 100% and a criterion of very suitable, media expert validation with a score of 81.09% and a criterion of quite suitable, media development testing with a score of 80.53% and a criterion of quite suitable, and field testing with a score of 86.32% and a criterion of very suitable. Therefore, Mepins is concluded to be very suitable for use by students; 3) The test of increasing student motivation is categorized as very high based on the results obtained from the motivation field test with an average score of 88.75% and an N-Gain value of 0.54 with a moderate interpretation. This indicates that the use of media can increase student motivation, especially in Informatics subjects

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