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Development of a Physics Integrated STEM Meguru Model Oriented by Local Wisdom for Students' Creative Thinking Skills

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Abstract: One of the existing learning approaches is challenge-based learning (CBL) which modified to Meguru, that encourages students to think critically and creatively in solving real problems. The STEM integrated CBL physics learning model based on local wisdom is present as an alternative to overcome these challenges. The main aim of this research is to develop a STEM-integrated physics challenge based learning model oriented to local wisdom towards quality students' creative thinking skills with valid, practical and effective criteria. This research is the Borg and Gall development model that was carried out through expert validation via FGD to obtain suggestions and input in order to revise the model, so that the valid Meguru model was obtained. The experts provide recommendations that the Meguru learning model was suitable for use with improvements (LDP). Validation of learning tools, obtained model implementation sheet with a score of 1.00 (very valid), teaching module with a score of 3.78 (very valid), student activity sheet (LKPD) with a score of 3.94 (very valid), student activity observation sheet with a score of 1 .00 (very valid), and the student response questionnaire was 98.66 (very valid). In the testing phase of the model's effectiveness, students' creative thinking skills were obtained with an average score of 97.50. The score obtained in the very good category shows that the learner's goals were achieved. where the Meguru learning model is effectively used in Physics learning. The type of research is development research or Research and Development (R&D).

Keywords: Creative thinking; Effectiveness; Meguru model; Practicality; Validity

Introduction

Minister of Education and Culture Regulation No. 22 of 2016 concerning Process Standards states that the learning process in educational units is carried out in an interactive, inspiring, fun, challenging manner, motivates students to participate actively, and provides sufficient space for initiative, creativity and independence in accordance with talents, interests and development physical and psychological of students(Chairunnisa et al., 2020). Therefore, each educational unit must plan, implement and evaluate learning activities so that efficient learning activities can be created that effectively increase the achievement of graduate competencies. Ideally, in learning activities teachers do not only use one type of learning model. There needs to be variations in the learning models used, which of course must be adjusted to the characteristics of the students. Teaching is based on understanding what is known and what students need will create effective learning. To create learning activities that can motivate students to be actively involved, appropriate learning strategies are needed.

The challenge based learning model is a new learning that combines problem-based learning, project-based learning, and contextual learning which is focused

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on solving problems that exist in everyday life (Haqq, 2017). This learning creates a space where students think creatively and actively look for solutions to solve existing challenges. The challenge based learning module is a module characterized by the syntax of challenge based learning which includes giving big ideas or main ideas, essential questions or giving important questions, challenges, guiding questions, guiding activities or guiding activities, solutions or solutions. , then publication. With this challenge based learning model, it is hoped that you will be able to develop creative thinking skills, which is one of the higher level thinking skills (Farizi et al., 2023). Challenge-based learning uses real life problems as challenges where students can apply their knowledge and skills in solving these challenges.

This approach can expand current practices, serve as a framework for specific events during the school year, and act as an overarching framework for strategic planning, decision making, and learning (Sodikin, 2015). Challenge-based learning is also one of the ideas used in learning, with replicable and measurable results for students at almost every grade level.

In order to support the success of skills in the 21st century, a strategy is provided by implementing the STEM integrated CBL model, namely the integration of science, technology, engineering and mathematics learning (Ash-showy et al., 2022). Integrative approach, a learning approach that uses several scientific disciplines. STEM Education can make students active, collaborative, skilled, and learning can be meaningful, thus broadening their horizons. In the context of primary and secondary education, STEM education has the aim of developing students who understand STEM (Bybee, 2013), who have: 1. Knowledge, attitudes, and skills in solving real-world problems, designing, explaining natural phenomena, and drawing conclusions based on evidence those about STEM; 2. Understand the characteristics of STEM as inquiry, knowledge, and proposed design; 3. The material, intellectual and cultural environment creates awareness of STEM disciplines; 4. Involvement in STEM studies as a concerned, constructive, and reflective citizen who uses the ideas of science, technology, engineering.

Development research stated that the STEAM approach helps students in character formation and provides positive encouragement in the development of affective knowledge which can improve students' cognitive skills. The development of the STEM approach to STEAM has had a better impact in accordance statement that STEAM learning also helps students to develop critical thinking, problem-solving and collaborative skills. The STEAM approach actively involves students in carrying out practical activities that can hone students' skills in providing more innovative ideas (Norlaili et al., 2022).

Teachers must be able to use learning strategies and media that can optimize students' creative thinking skills. Using appropriate, varied learning models, teaching well, and using good questions are the main supporting factors in classroom learning (Badawi et al., 2016). Therefore, it is necessary to have an appropriate learning model to develop students' creative thinking skills. One lesson that can be applied is Physics Learning, challenge-based learning (CBL). Challenge based learning is defined as a problem-based learning model that uses realistic and natural problems (Johnson & Adams, 2011).

In the context of the Independent Curriculum, the importance of combining elements of local wisdom in the learning process is emphasized, which aims to support the achievement of student profiles in accordance with the principles of Pancasila. Therefore, teachers are expected to prepare learning materials that are in accordance with the Independent Curriculum, which integrates elements of local wisdom.(Jufrida et al., 2023)

According (M.Habibie et al., 2024) Integrating local wisdom in learning at school can create learning that not only provides students with knowledge, but also instills it love for local diversity in the environment. Based on the description above then research needs to be carried out on developing teaching modules based on local wisdom.

Method

The learning model developed in this research is the Meguru learning model. The development design uses the Borg and Gall 1989 (Schratz, 2020). Development research begins with the preliminary study stage, model development/validation and model testing/implementation. Testing the validity of the test uses the product moment correlation test (Wright, 2008), with the equation:

$$r = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}} \quad (1)$$

The preliminary stage consists of a theoretical study (literature study) and an empirical study (field study). The results of theoretical studies and empirical studies as a basis for producing hypothetical models at the development stage. The quality of the resulting hypothetical model was measured criteria, namely validity, practicality and effectiveness (Asfar & Asfar, 2020).

The sample in this research was Senior High School 2 Palu with 32 students. This instrument was

developed to collect data about whether prototypes (models, devices and instruments) are valid or not. The data obtained with this instrument is used to determine the level of validity of the prototype(Aminah, 2016). Meanwhile, the data sources are competent experts. There are several assessment sheets used to determine whether the prototype in this research is valid or not, namely: The research instruments developed are: (1) Assessment (validation) sheet for prototypes (models, devices and instruments), (2) Observation sheet on the implementation of the learning model (LOKMP), (3) Student and teacher activity observation sheet (LOASG), (4) Skills observation sheet (5) Formative test, and (6) Student response questionnaire (ARS). `All the instruments mentioned above were developed by researchers to collect needed data in developing learning models.

Implementation of a learning model based on local wisdom in preparing relevant essay questions and student worksheets (LKPD) by linking physics learning material related to local culture. For material on temperature and heat which highlights the regional characteristics of Central Sulawesi province, the process of making Bomba weaving and the process of making Talise salt which is connected to the drying process can increase students' understanding of their own culture and also increase their sense of belonging to this cultural heritage.

Teachers can adapt essay questions to local wisdom which is an important part of students' lives. In this way, students will more easily understand the concepts being taught and be able to relate them to their daily lives. Apart from that, composing essay questions that are relevant to local wisdom can also increase students' interest and motivation in learning, because they feel that the material studied has real value in their lives (Gunawan et al., 2023).

In the current digital era, the use of technology can be an effective way to improve learning based on local wisdom. Teachers can use online platforms to share learning materials, discussions and assignments with students. Apart from that, the use of multimedia such as video, audio and images can also help students understand the concepts being taught better. Thus, the application of technology can enrich students' learning experiences and increase their involvement in local wisdom-based learning.

Referring to several inputs from validators, modifications were made to improve the Meguru learning model teaching module. The results of this Meguru revision divide learning activities into 6 syntax, namely: (1) Context analysis; (2) Challenge; (3) Guide solutions; (4) Action; (5) Evaluation; (6) Publish. This also needs to be addressed in delivering material that is more concise and clear so that it is easy for students to review and understand as a target for improving high-level thinking skills. At the learning stage, it is necessary to ensure the link between the material and the learning model and to enrich information about the learning material.

Result and Discussion

Introduction to the assessment data based on gender and age will be discussed in this chapter. This data is important for understanding the differences in assessment outcomes between men and women, as well as between different age groups. By understanding these factors, we can identify potential biases in the assessment process and take steps to address them. Additionally, understanding these differences can also help us design more inclusive and fair assessment strategies for all individuals.between men and women has become a hot topic of discussion in the world of education. Many studies have shown a gap in assessment results based on gender, where some findings indicate that boys tend to excel in certain subjects while girls excel in others.

The data from expert assessments on the relevance of the Meguru model in Table 1. illustrate that the Meguru model has relevance categorized as valid and very valid in all assessed aspects, and generally categorized as very valid. Additionally, the Meguru model shows that it is based on a strong theoretical foundation.

Table 1. Results of expert assessment of the relevance of the Meguru model.

Aspect Being Assessed	Average Assessment	Percentage Validity
Objective	90.00	Highly valid
Supporting Theory	92.50	Highly valid
Learning Syntax	82.50	Valid
Learning Environment	92.50	Highly valid
General Validation Conclusion	89.37	Highly valid

Table 2. Expert assessment results and validity categories of the Meguru model teaching module.

Aspect being evaluated	Average Score and Validity Category of the Teaching Module				
	L1	L2	L3	X	Validity
Goal Formulation /Indicator	4.0	4.0	3.7	3.9	Highly valid
Material	3.8	3.8	3.6	3.8	Highly valid
Language	4.0	4.0	3.8	3.9	Highly valid
Time Allocation	3.8	3.8	3.5	3.7	Highly valid
Learning Activity	4.0	4.0	3.5	3.8	Highly valid

Table 3. Results of Expert Assessment of the Meguru Model Implementation Sheet

Rated aspect	Average expert assessment	Validity Category
Instruction	1.00	Very valid
Fiil	1.00	Very valid
Languange	1.00	Very valid

Based on the assessment results from material experts, it shows an average percentage of 100%. In the assessment given by the validator, it is stated that the learning tools created are suitable for use because they meet the requirements in terms of attractiveness, practicality and easy to use, and can motivate students in learning.

Practicality of Meguru Learning Tools

The practicality of the Meguru model learning tools can be seen from the implementation of the teaching modules and LKPD which are supervised by two observers.

Table 4. Student Practically Rating

Average rating	Persentage of Agreement	Category
3.50	87.50%	Very good

Results of Analysis of Student Learning Activities

Student activities in the learning process were observed by two observers. Observations are made during the learning process, from the beginning to the end of the lesson. The types of student activities observed by observers were 32 students in the experimental class with new learning. The learning process was carried out using two study groups, namely the experimental group and the control group.

Table 5. Student activity observation sheet assessment results

Rated aspect	Average expert assessment	Validity Category
Instruction	1.00	Very valid
Fiil	1.00	Very valid
Languange	1.00	Very valid

Table 6. Student attitude observation sheet assessment results

Rated aspect	Average expert assessment	Validity Category
Instruction	1.00	Very valid
Fiil	9.75	Very valid
Languange	1.00	Very valid

In measuring competence, collaborative and communicative, carried out by observing students during the learning process, the observation results obtained by the experimental group obtained an average percentage score of 83.03%.

Effectiveness of Meguru Learning Tools

Student Responses Student response questionnaires are given to students after the final test. In general, students' responses to the Meguru Model that were developed showed an average percentage of 98.66%, which means that the majority of students gave positive or very strong responses while the rest were less happy and interesting responses to the learning carried out.

Table 7. Student Response Questionnaire Assessment Results

Rated aspect	Average expert assessment	Validity Category
Instruction	1.00	Very valid
Fiil	1.00	Very valid
Languange	1.00	Very valid

Results of the Creative Competency Test. The questions were tested on 32 students of class In this research, a validity test was carried out to measure the level of validity and suitability of the questions to be used. This is processed using product moment correlation with the help of SPSS version 26. In the learning activities carried out, measuring creative competence according to students' intelligence characteristics is carried out using tests, types of descriptive questions given for the experimental class and control class.

Tabel 8. Results of expert assessment of students' creative thinking skills instruments

Rated aspect	Average expert assessment	Validity Category
Objective	95.0	Very valid
Construction	1.00	Very valid
Languange	97.5	Very valid

The data from this research includes (1) pretest data on creative thinking skills for the experimental class and the control class, (2) posttest data on creative thinking skills for the experimental class and the control class, and (3) gain score data with effect size on creative thinking skills for the experimental class and the control class. For a clearer understanding, the average data on students' creative thinking skills can be seen in the table 8.

Table 9. Descriptive statistics of students based on gender

Gender	Category	Grup	N	Min.	Max.	Mean	Std. dev.
Female	Pre	Eksperiment	21	7	17	11.762	2.385
		Kontrol	21	7	15	11.333	1.932
	Post	Eksperiment	21	13	20	19.286	1.586
		Kontrol	21	17	20	19.476	0.981
Male	Pre	Eksperiment	11	9	17	12.909	2.212
		Kontrol	11	7	16	13.091	2.587
	Post	Eksperiment	11	11	20	17.818	2.750
		Kontrol	11	14	20	18.818	1.940

Table 10. Reliability statistics gender female

Grup	Category	Cronbach's Alpha	Information
Eksperiment	Pre	0.62	Reliabel
	Post	0.60	Reliabel
Control	Pre	0.62	Reliabel
	Post	0.75	Reliabel

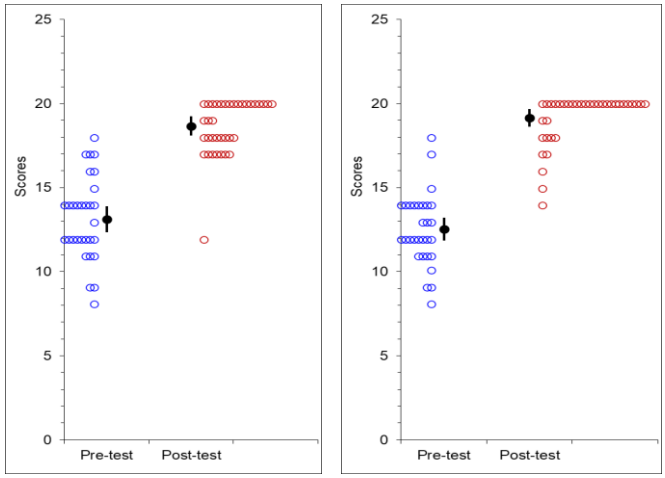
Table 11. Reliability statistics gender male

Grup	Category	Cronbach's Alpha	Information
Eksperiment	Pre	0.76	Reliabel
	Post	0.77	Reliabel
Control	Pre	0.70	Reliabel
	Post	0.60	Reliabel

After validity is carried out, the 5 questions that will be tested are valid, next is reliability testing using Chronbach's Alpha correlation processed using statistics software.

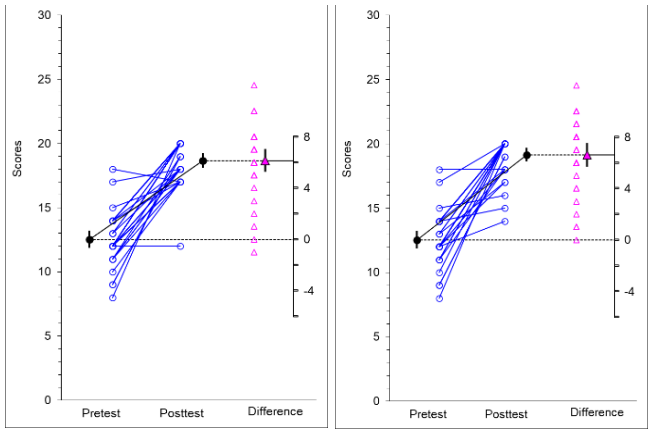
However, it is important to remember that these differences do not always indicate differing intellectual abilities between males and females, but rather can be influenced by social and cultural factors that affect the learning process. Differences in assessment outcomes based on gender can have significant consequences in terms of educational and career opportunities, as well as in the formation of individual identity. Therefore, it is important to continue conducting in-depth research and analysis to further understand the factors influencing these differences and how they can be addressed to create equality and justice in education.

One potential challenge in implementing the Meguru model in education is resistance from traditional educational institutions that may be resistant to change. Another challenge could be the need for extensive training and professional development for teachers to effectively implement the Meguru approach in their classrooms. Additionally, there may be logistical challenges in terms of scheduling and resources needed to fully integrate the Meguru model into existing curriculum. Despite these challenges, there are several strategies that can be employed to overcome them, such as providing ongoing support and mentorship for teachers, creating a supportive school culture that values innovation and experimentation, and fostering collaboration between teachers and administrators to ensure successful implementation of the Meguru model. As we look towards the future, it will be important to continue researching the impact of Meguru on student engagement and learning outcomes, as well as exploring new ways to scale up the use of the model in schools and institutions. By addressing these challenges and continuing to innovate and adapt, we can ensure that the Meguru model has a lasting and meaningful impact on education.



(a) Experiment Class (b) Control Class

Figure 1. Distribution of pretes and posttest score in experiment class and control class



(a) (a) Experiment Class (b) Control Class

Figure 2. Class pair data Experiment class and Control class

Broadens views and perspectives in facing daily challenges - Helps in creating unique and effective solutions - Increases ability to adapt to changes and unexpected challengesto provide a deeper understanding of the importance of creative thinking skills in living everyday life. By understanding the concept and benefits of this skill, it is hoped that readers can develop themselves and become more creative and innovative individuals in dealing with various situations they face every day.Thus, it can be concluded that creative thinking skills are an important aspect in facing various challenges in everyday life. Through the ability to broaden views and perspectives, and create unique and effective solutions, a person can increase their ability to adapt to unexpected changes and challenges. This can also enrich life experiences and broaden one's horizons. Therefore, it is important for each individual to continue to develop creative thinking skills through regular practice and exploration of new ideas.

There are two groups of data represented by open blue circles: the Pre-test group on the left and the Post-test group on the right. Each open blue circle represents one individual data point. Two black dots with error bars represent the mean and standard deviation of each group. In the Pre-test condition, the average transcription percentage was around 13%, while in the Post-test it increased to around 19%.

This graph shows an increase in the transcription percentage from Pre-test to Post-test, indicating the effect of the intervention or treatment provided. It shows the transcription percentages before and after the test.(Pre-test dan Post-test). The blue circular dots represent individual data, while the black dots with vertical lines represent the mean and confidence interval of the data.

Confidence interval (CI) in this graph is represented by the vertical line passing through the black dot. Confidence interval (CI) provides a range of values that may contain the true average value of the population. In the context of this graph, Confidence interval (CI) indicates how certain the measured average transcription percentage is. The shorter the vertical line, the higher the level of certainty that the calculated average is close to the true average of the population.

In this graph, the confidence intervals for the Pre-test and Post-test appear different. The confidence interval for the Post-test is higher compared to the Pre-test, indicating that there is an increase in the transcription percentage after the test. It shows a confidence interval of around 95%. Therefore, there is a 95% chance that the true average of the population lies within the range of values indicated by the vertical lines around the black dot.

In the Pre-test group, the average transcription percentage is around 13% with a confidence interval of approximately 11% to 15%. In the Post-test group, the average transcription percentage is around 19% with a confidence interval of approximately 17% to 21%. Therefore, there is a significant increase in the transcription percentage from Pre-test to Post-test.

Confidence Interval (CI) on this graph is approximately 95%. In the Pre-test condition, the average transcription percentage is around 14% with a CI ranging from 13% to 15%. Meanwhile, in the Post-test condition, the average transcription percentage is around 19% with a CI ranging from 18% to 20%. Therefore, this CI indicates that there is a 95% chance that the actual average transcription percentage falls within this range.

In the Pre-test condition, there are many data points scattered between approximately 10% and 20%, with some points below 10%. The black point with the error bar indicates the mean and standard deviation of the Pre-test data, which is around 15%. In the Post-test condition, the data points are more concentrated between 15% and 20%, with the mean and standard deviation indicated by the black point with the error bar being around 20%.

The graph above shows the transcription percentage in two conditions: Pre-test and Post-test. On the y-axis is: "Transcription %" ranging from 0 to 25, and on the x-axis are the two conditions mentioned earlier. The blue dots represent individual data points, while the black dots with error bars indicate the mean and confidence interval of the data. The confidence interval (CI) in this graph is represented by the vertical line passing through the black dot. CI provides a range of values that may contain the true mean of the population with a certain level of confidence (usually 95%). In this graph, the CI for the Pre-test and Post-test indicates that the average transcription percentage for both conditions is different, with the Post-test having a higher average and a narrower CI compared to the Pre-test. This indicates that after the intervention or treatment, the transcription percentage increased and the results were more consistent.

Creative thinking is a form of cognitive aspect that requires every individual to try to produce creative solutions or products. Creative thinking skills are really needed by humans in facing global challenges in the 21st century which are currently developing very rapidly. So creative thinking can help find solutions to solve the problems being faced. When students are given a problem and are able to solve it by proposing new opinions or ideas well, then the student's creative thinking skills can be said to have developed. In developing creative thinking skills, each person will go through the stages of synthesizing, planning the ideas that will be implemented, so that they can produce new creativity.

Creative thinking skills assessment is the process of evaluating an individual's ability to generate innovative ideas, think critically, and solve problems in unique ways. It is crucial to assess these skills as they play a vital role in fostering innovation, driving growth, and overcoming challenges in today's rapidly changing world. By measuring creative thinking skills, organizations can identify and nurture talent, enhance decision-making processes, and ultimately achieve their strategic goals.

Creative thinking skills can be defined as the ability to generate new ideas, think outside the box, and approach problems from different perspectives. Developing these skills is crucial in today's fast-paced and ever-changing world, where innovation and adaptability are highly valued. By honing creative thinking skills, individuals can become more effective problem solvers, better decision makers, and more successful in their personal and professional lives. In this study, we will explore how the use of Meguru, a cutting-edge educational tool, can enhance creative thinking skills in students of all ages.

The implementation of Meguru in various settings has shown promising results in enhancing creative thinking skills. By encouraging curiosity and exploration, individuals are able to think outside the box and generate innovative ideas. Additionally, promoting divergent thinking allows for the exploration of multiple solutions to a problem, leading to more creative and unique outcomes. Furthermore, fostering a growth mindset helps individuals overcome obstacles and challenges, ultimately leading to greater creative thinking abilities. These techniques, when applied effectively, can have a significant impact on an individual's or organization's ability to think creatively and generate innovative solutions.

Conclusion

With Meguru's focus on enhancing creative thinking skills, individuals are empowered to think outside the box and approach problems from different angles. This not only leads to innovative solutions but also fosters a mindset of continuous improvement and adaptability. By embracing creativity, individuals can stay ahead of the curve and seize opportunities for growth and success in a rapidly changing environment. Meguru's impact on enhancing creative thinking skills is evident in the way it empowers individuals to unleash their full potential and thrive in today's dynamic and competitive world.

Meguru provides a platform for individuals to explore new ideas and experiment with unconventional approaches, ultimately leading to breakthroughs and advancements in various fields. The program encourages participants to embrace challenges and view failures as opportunities for learning and growth. By cultivating a culture of creativity and innovation, Meguru equips individuals with the tools and mindset necessary to navigate the complexities of the modern world and make meaningful contributions to society.

One way to incorporate traditional knowledge and practices in STEM curriculum is through collaboration with local communities and experts. By working closely with individuals who have a deep understanding of the cultural context, educators can ensure that the content is not only accurate but also respectful of local values and beliefs. In conclusion, it is evident that developing creative thinking skills is crucial for individuals and organizations to thrive in today's rapidly changing world. By encouraging divergent thinking, promoting a growth mindset, and providing a supportive environment for creative exploration, individuals can unlock their full potential and come up with groundbreaking ideas. It is important to continuously nurture and cultivate these skills in order to stay ahead of the curve and remain competitive in an increasingly innovative landscape. Creative thinking is not just a valuable asset, but a necessity for success in the modern world.

Without creative thinking, individuals risk falling behind and becoming stagnant in a world that values innovation and adaptation. Embracing creativity allows for new perspectives, fresh solutions, and the ability to navigate challenges with ingenuity. By fostering a culture that values and prioritizes creative thinking, individuals and organizations can position themselves as leaders in their industries and continue to thrive in an ever-evolving landscape. Ultimately, creativity is the key to unlocking endless possibilities and achieving success in today's dynamic and competitive world.

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