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The Impact of Project Development Training on Problem-Solving Skills in The Case of Gifted High School Student

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Abstract:
This study aimed to determine the impact of project development training on the problem-solving skills of gifted students. For this purpose, project development training was administered to gifted students. Prior to the training, a problem-solving skills perception scale was applied as a pre-test. Following the training, the same scale was applied as a post-test, and interviews were conducted with participants regarding their experiences. Mixed-method procedures were utilized in the study. According to the results, most students reported improvements in academic writing, reporting, and presentation techniques. After the training, students generally found the process functional. Additionally, the training increased their curiosity and motivation for research, and enhanced their problem-solving, creative and analytical thinking, The quantitative results indicated that participants' perceptions of their problem-solving skills increased significantly after the project training, suggesting a more positive perception of these skills.

Anahtar Kelimeler: Gifted students, Problem solving, Project-based learning.

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INTRODUCTION

In modern societies, individuals are expected to identify encountered problems and produce creative, critical, rational, and effective solutions (Gardner, 1993; Dewey, 1910; Robinson & Aronica, 2015). In this context, Project-based Learning (PBL) is an effective learning approach that improves students' ability to access and utilize information (Dağ & Durdu, 2012). PBL provides more effective outcomes in planning, problem solving, communication, decision making, quality learning, developing a positive attitude towards the course, and applying acquired knowledge to new situations (Thomas, 2000). It also supports students' higher-order thinking skills, such as collecting, analysing, and interpreting data (Diffily, 2002). PBL advocates those educational activities should be learner-cantered, making learning more functional (Taşkın & Karakuş Tayşi, 2018). It has been found that project activities have a significant positive impact on the research and inquiry skills (Kiliçkiran & Korkmaz, 2021), critical thinking skills (Suprapto et al., 2024), creative and metacognitive thinking skills (Börekci & Uyangör, 2019), and learning autonomy of gifted students (Çetinkaya, 2021). Additionally, interviews revealed that gifted students have positive opinions about collaborative project activities (Kiliçkiran & Korkmaz, 2021; Özbek & Dağyar, 2022). In Turkey, Science and Art Centres[1] (SAC) are special education centres that provide project-based learning (Ministry of National Education, 2024). In this regard, PBL aligns with the educational approach of SACs (Ministry of National Education, 2024). However, it appears that the PBL in SACs is not sufficiently focused on problem-solving and preparing gifted students for professional life (Özer, 2020). Teachers working in SAC, believe that periodic training should be provided for students and teachers on project topic selection, management, and reporting (Nacaroğlu & Arslan, 2019). Studies investigating the impact of teachers using PBL in their classes on the problem-solving skills of gifted students have reached positive results (Korkmaz, 2002; Markham, 2011). Research has been conducted on the problem-solving skills of gifted students. According to these studies, gifted individuals have creative solutions to problems (Alabbasi et al., 2021; Keleş, 2022). Additionally, there is a positive relationship between these students' problem-solving skills and their metacognitive awareness and reading comprehension (Bayraktar & Sümen, 2024). Findings indicated high levels of reflective writing skills and interdisciplinary connections based on real-world problems in their projects (Alabbasi et al., 2021; Keleş, 2022; Bayraktar & Sümen, 2024). Girgin (2020) evaluated the effects of PBL on gifted students through reflective diaries. Similarly, another study discusses how PBL meets the needs of gifted students in social studies (Diffily, 2002). However, there is no study investigating the impact of gifted students' project development and management skills on their problem-solving abilities. The literature lacks studies directly examining the effect of providing project development training to gifted students on their problem-solving skills.

Research Aim and Research Questions

This study aims to determine the impact of project development training on the problem-solving skills of gifted students. While numerous studies examine the application of the PBL approach in various aspects in SAC, the unique aspect of this study is investigating the outcomes of gifted students learning the PBL approach and engaging in project activities accordingly. The dependent variable analysed is students' perceptions of their problem-solving skills.

To achieve more detailed findings, the study addresses the following research questions:

[1] Science and Arts Centres (SAC)

1. What are the views of gifted high school students on project development training?
2. What is the impact of project development training on gifted students' perceptions of problem-solving skills?

Theoretical Perspective

Gifted individuals, who exhibit superior characteristics in intelligence, creativity, and motivation compared to their peers (Renzulli, 1978), are crucial for the future of societies. To maximize the potential of gifted individuals and address their special needs, they should receive specialized education distinct from their peers (Renzulli, 1977; Sternberg, 1985; NAGC, 2010). On average, 2% of a population is considered gifted (Silverman, 2012; Terman, 1925). Globally, various practices are implemented for the education of gifted students (Shavinina, 2009; Carlsson-Paige et al., 2013; Wallace et al., 2010). In Turkey, SAC provide special education for students who can learn faster than their peers, have special academic abilities, and excel in creativity, art, and leadership (MEB, 2019). While gifted students continue to receive education with their peers in their regular schools, they also receive education in SACs. Gifted children stand out due to their creativity, intelligence, academic skills, and leadership characteristics (Hallahan & Kauffman, 1994). However, their desire for perfection and fear of making mistakes can cause intense anxiety and emotional reactivity. According to Webb et al. (2007), gifted children may believe “they will be loved only if they are successful, leading to introversion and timidity. Preventive intervention programs are recommended to address these and similar issues (Ağaya et al., 2023). One effective preventive approach is the project-based learning (PBL) method, which allows students to learn collaboratively. Numerous studies reveal the positive effects of PBL on learning outcomes. PBL positively affects the development of students' creative abilities through collaborative teamwork (Xu & Liu, 2010), solving interdisciplinary problems and providing out-of-school learning environments (Kaldi, Filippatou, & Govaris, 2011), preparing students for real life by providing life experience (Zimmerman, 2010), enhancing scientific process skills and academic achievement (Yılmaz, 2015), and fostering self-efficacy perception and metacognitive skills (Kocaman, 2016). Today, individuals have numerous options for accessing information. However, the ability to use information effectively should not be overlooked (Şimşek et al., 2021; Koparan, 2022; Kahneman, 2017).

SACs in Turkey serve to identify and nurture the talents of gifted students by adopting a project-based education approach. SACs aim to develop the creativity, leadership abilities, critical thinking, and problem-solving skills of these students. Therefore, investigating the relationships between project-based learning and problem-solving skills within the educational context of SACs appears to be a reasonable approach.

METHOD

Research Design

This study investigates the role of project development training in enhancing the problem-solving skills of high school students identified as gifted. In this context, a pre-test was administered before the project development training commenced, and a post-test was administered after the training concluded. Participants' views on the training process, project-based learning, and problem-solving skills were assessed after the training. Quantitative data were obtained from the pre-test and post-test of the Problem-Solving Skills Scale. Qualitative data were gathered from interviews with participants. Thus, both qualitative and quantitative research approaches were utilized, employing a mixed-methods design. In this design,

qualitative data are integrated with quantitative data, either emphasizing quantitative data or embedding quantitative data into qualitative data (Creswell, 2015). Mixed-methods approach entails collecting both qualitative and quantitative data to comprehensively address the research questions and synthesizing the results (Creswell, 2011, pp. 2-8). Additionally, the effect of an experimental procedure was tested on a single group, categorizing it as a weak experimental design (Büyüköztürk et al., 2023, pp. 208-209). Consequently, procedures suitable for both semi-experimental and mixed-methods designs were applied in study.

Participants and Implementation

Participants comprised students from Alanya Science and Art Centre (Alanya SAC) located in Alanya District of Antalya Province and fourth-year students from the Faculty of Education at Alanya Alaaddin Keykubat University. The first group consisted of student participants, while the second group included advisor participants in the research. In the selection of students, typical purposive sampling, a form of non-random sampling, was used to select participants. This sampling method is expected to represent various situations related to the population and to exhibit average characteristics (Büyüköztürk et al., 2023, pp. 94-95). It is assumed that this sample can represent gifted students in multiple aspects. Participants were required to attend at least 80% of the training sessions. 16 students who did not meet this criterion and did not complete all tasks were excluded from the study. Consequently, the study group consisted of 25 gifted high school students.

Table 1. Descriptive Statistics of The Gifted High School Students

			N	%
Quantitative	Sex	Female	17	68
		Male	8	32
	Class	9.	11	44
		10.	8	32
		11.	6	24
		Total	25	100
Quantitative	Sex	Female	5	50
		Male	5	50
	Class	9.	6	60
		10.	2	20
		11.	2	20
		Total	10	100

As seen in Table 1, 68% of the participants were female (n=17) and 32% were male (n=8). 44% of the participants were 9th grade students (n=11), 32% were 10th grade students (n=8) and 24% (n=6) were 11th grade students.

The advisors are comprised of fourth-year students from the Faculty of Education at Alanya Alaaddin Keykubat University. During the project development training, the advisors provided guidance on project development to between 1 and 3 gifted high school students. The criteria for selecting advisors included their willingness to volunteer for consultancy and their completion of the 'Project Training' course offered as an elective in the Faculty of Education. Accordingly, 22 students from the Faculty of Education participated in the research as advisors throughout the study.

Implementation and Procedures

In the project-based approach, where students organize their own learning through hands-on experience, the process includes several stages Moursund (1999). In the implementation phase of this study, project development training was provided according to this framework. Additionally, activities to improve academic writing skills were included in the training (Newell et al., 2014; Shanahan, 2016). Therefore, the conceptual framework of this study encompasses project-based learning, academic writing, and problem-solving skills. The implementation stages of the project development and writing training are presented in Table 2.

Table 2. Training Process

Week	Duration/Time	Subject
1	1	Establishing group dynamics
	1	Conceptual framework
2.	1	Scientific research methods
	1	Literature review and problem determination
3	1	Data collection techniques and tools
	1	Data analysis techniques and tools
4	1	Problem identification
	1	Solution generation
5	1	Project support funds
	1	Academic writing
6	1	Communication skills
	1	Presentation techniques and tools
7	1	Project presentations
	1	Evaluation

As seen in Table 2, the project development training lasted for 7 weeks and 14 hours in total. During the training process, in accordance with the principles of scientific research and academic writing, gifted high school students developed, implemented and reported a project related to a problem they identified.

Data Collection Tools

Within the scope of the study, two data collection tools were utilized.

Problem-solving skills scale (PS)

This scale, developed by Sarıkaya and Özgöl (2015), evaluates students' perceptions and approaches towards problem-solving processes. Named as the Problem-Solving Skills Scale in this study, it is a five-point Likert-type scale consisting of 20 items. Each item expresses a specific problem-solving behaviour of the students, including both positive and negative statements regarding problem-solving skills. Descriptive statistics of the PS are presented in Table 3.

Table 3. Problem Solving Skills (PS) Scale Descriptive Statistics

Item	Pre-test Mean	Post-test Mean	Difference
1	3.68	4.13	+
2	3.88	4.25	+
3	3.64	3.71	+
4	4.08	3.71	-
5	3.2	3.58	+
6	4.12	3.83	-
7	3.56	3.92	+
8	3.04	3.46	-
9	3.8	3.54	-
10	3.04	3.88	+
11	4.04	3.92	-
12	3.16	3.88	+
13	3.52	4.08	+
14	3.76	4.50	+
15	4.2	4.33	+
16	2.92	3.79	+
17	4.4	4.29	-
18	2.96	2.50	-
19	3.28	3.83	+
20	3.68	3.83	+

According to Table 3, when comparing pre-test and post-test item averages, 13 items showed positive changes, while 7 items showed negative changes, indicating that most items changed positively after the experiment.

Interview form (IF)

In this study, participants underwent project development training. Their views and perspectives were evaluated within the framework of project development process, academic writing, and problem-solving skills (Patton, 2014). Interviews can be structured, unstructured, or semi-structured based on the level of question determination. Including focus group interviews, there are four types of interviews (Creswell, 2013). This study utilized semi-structured interviews. The interview followed specific stages: thematization, design, interview, transcription, analysis, confirmation, and reporting (Kvale, 1994). Questions were formulated by researchers according to themes identified in the design phase. The interview form comprised 6 questions, divided into sub-dimensions to provide flexibility to participants and depth to the interview. After reviewing the questions, the interview form was finalized. The interviews were conducted under organized conditions and audio recorded. Audio recordings were transcribed, and out-of-context content was excluded from the data set. Content analysis was performed by the researchers. The content was coded and organized. During the confirmation and reporting stage, the coding and relationships were reviewed by an external field expert. Based on the suggestions, the final version of themes, categories, and codes was determined.

Data Analysis

This section outlines the methods used to analyse both qualitative and quantitative data collected during the study.

Qualitative data analysis
Qualitative data were obtained from semi-structured interviews. These data were analysed using content analysis techniques. In the analysis phase, the data were coded, and themes, categories, and relationships were identified and interpreted considering the research questions (Mayring, 2014; Huberman & Miles, 2016). A commonly used qualitative data analysis software was employed to facilitate the coding and analysis process. The steps involved in the qualitative analysis included:

Coding: Identifying segments of text relevant to the research questions.
Categorizing: Grouping codes into broader themes and categories.
Interpreting: Analysing themes to derive insights aligned with the research objectives.

Quantitative data analysis
Quantitative data were obtained from the Problem-Solving Skills Scale (PS). The first step in the quantitative analysis was to check whether the data met the assumptions of normal distribution. This was done using the Kolmogorov-Smirnov test for the pre-test and post-test data.

Table 4. Kolmogorov-Smirnov test for PS

	N	X	SD	p	Skewness	Kurtosis
Pre-test	25	3.59	.39	.42	.87	.16
Post-test	25	3.87	.44	.13	-.31	-.79

The skewness and kurtosis values were within the acceptable range of ±2, indicating that the data were normally distributed (Mangal, 2002; Tabachnick & Fidell, 2013). As shown in Table 6, the data met the assumption of normality, allowing the use of parametric tests for further analysis.

Given the normal distribution of the data, a paired sample t-test was applied to the pre-test and post-test scores from the PS to evaluate the effect of project development and writing training on the problem-solving skills of gifted students (Büyüköztürk, 2018, pp. 67-70).

Ethics Committee Approval
Ethics Committee Approval dated 20 May 2024 and numbered 186117/20 was granted by the Social Sciences and Humanities Scientific Research and Publication Ethics Committee.

FINDINGS

Qualitive Findings
The concept map resulting from the content analysis of the qualitative data in the research can be seen in Figure 1.

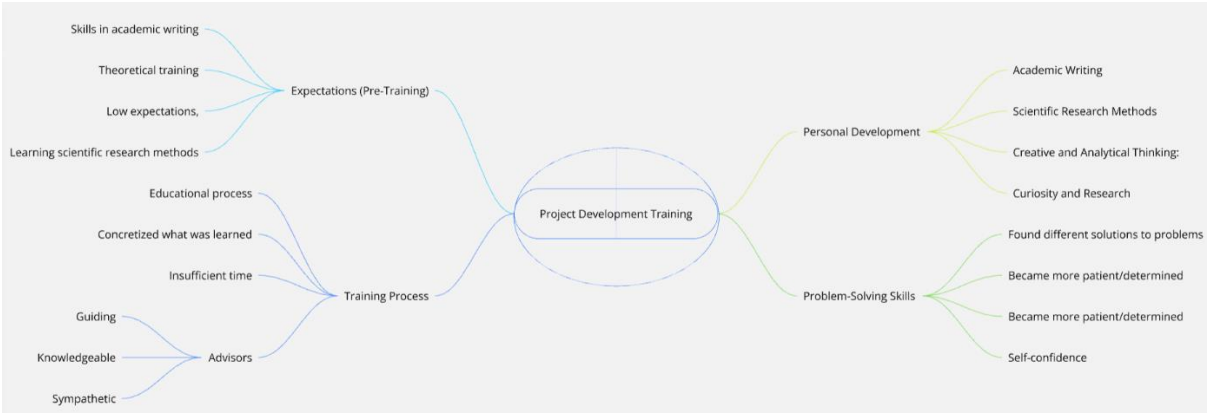

Figure 1. Content Analysis

As seen in Figure 1, the central theme is "Project Development Training". The sub-themes that make up this theme, the categories that constitute the sub-themes, and the relationships among them are as follows.

The expectations of gifted students from the project training before the implementation have been identified

Table 5. Students' Expectations from The Project Training Before the Implementation

Opinions	f
To acquire skills for academic writing and scientific process	5
To receive theoretical training on project writing	2
Not to have high expectations	2
To learn scientific research methods	1
Total	10

Before the training, 5 students expected to gain skills in academic writing and scientific processes. Others anticipated theoretical training on project writing (2) and did not have high expectations (2). One student wanted to learn scientific research methods.

"To learn to use more academic language in preparing presentations and writing academic reports" (S9).

"Actually, I had no expectations. I thought it would be the same as before" (S3).

Table 6. Students' Views on Project Training

Subcategories	Code	f
The process	The process was educational	7
	Time was not enough	2
	We concretised what was learned	1
The trainers	The trainers were guiding	6
	They were equipped	2
	They were sympathetic	2
Students	Project training was instructive for me	7
	I had fun in the project training.	2
	Project training was boring	1
Total		30

Regarding the training process, 7 students found it educational, though 2 felt the time was insufficient. One student noted that the training helped solidify their learning. The trainers were considered guiding (6), equipped (2), and sympathetic (2). As for the students' personal experiences, 7 found the training instructive, 2 enjoyed it, while 1 found it boring.

"I am satisfied, I learnt to use Microsoft Word in more detail. I gained in-depth knowledge about slide programmes" (S1).

"I think the process was used efficiently and effectively. There was enough time for the projects. The lesson hours were enjoyable and educational" (S6).

Project training contributed to students' personal development in several ways:

Table 7. Opinions On the Contribution of The Project Training to The Personal Development of The Students

Subcategories	Code	f
Academic writing	My ability to use academic language has improved	5
	I learnt the rules of academic writing	3
	I gained report writing skills	2
Scientific research methods	I learnt to choose a method / design	5
	I learnt how to do literature review	4
	I learnt the stages of scientific research.	1
Creative and analytical thinking	I have acquired the ability to find creative and innovative topics	4
	I gained analytical perspective in the research process	3
	It enabled me to produce different solutions to problems	2
	It developed my imagination and creativity	1
Increasing curiosity and research	It developed my sense of curiosity	5
	My desire to do research increased	3
	It did not develop my sense of curiosity	2
Total		40

Academic writing: Students improved their academic language skills (5), learned writing rules (3), and gained report writing skills (2).

Scientific research methods: Students learned how to select research methods/designs (5), conduct literature reviews (4), and understood research stages (1).

Creative and analytical thinking: Students developed skills to find innovative topics (4), gained analytical perspectives (3), and found different solutions to problems (2).

Curiosity and research: The training increased their curiosity (5) and desire to conduct research (3), though 2 did not experience an increase in curiosity.

"As I saw the research on the recommended sites during the resource search, I had more different and new ideas in my mind" (S8).

"I learnt about qualitative and quantitative research methods and used them in my project" (S6).

Table 8. Opinions On the Contribution of Project Training to Participants' Problem-Solving Skills

Code	f
Project training enabled me to find different solutions to problems	5
Project training helped me to be patient/ determined	4
Project training made me confident in myself	3
Project training helped me to face the problems	1
Project training helped me to stay calm	1
Total	14

According to Table 8, the opinions of the gifted students whose opinions were taken within the scope of the research on the contribution of project education to problem solving skills were mostly in the direction that project education enabled them to find different solutions to problems (f=5). This was followed by the views that project education enabled me to be patient/determined (f=4), project education enabled me to trust myself (f=3), project education enabled me to face problems (f=1), and project education enabled me to stay calm (f=1). Direct quotations from the responses of gifted students to this question are given below.

"I did not know all the ways I could solve the problem. Now that I have learnt different ways, I can try all ways" (S3).

"Although I was unsuccessful in requesting data from official institutions, I focused on continuing the research" (S4).

Table 9. Opinions On the Contribution of Project Training to Participants' Academic Development and Competences

Subcategories	Code	f
Access to information, documents and resources	I know what to find and where to find it	4
	I can access information more easily	3
	I learnt how to search safely	2
	I question the source of information	1
Processing the data obtained	I learnt to store the data I obtained	6
	I learnt to organise the data I obtained	1
Making article-project work	I will	6
	I will and I decided after this training	4
Total		27

According to Table 9, Project training enhanced academic development and competencies:

Accessing information: Students became adept at finding relevant information (4), accessing it easily (3), searching safely (2), and questioning sources (1).

Processing data: They learned to store (6) and organize data (1).

Article-project work: Students were motivated to write articles or projects (6), with 4 deciding to do so due to the training.

"Since time is important in research, I learnt how important it is to keep all the information learned in the process" (S7).

"I realised how I can access the needed documents and articles more easily and use them effectively" (S6).

"It helped me to find the right source and to understand which one is reliable" (S3).

Quantitative Findings

This section presents the impact of the training on the participants' perceptions of their problem-solving skills.

Table 10. Problem Solving Skills t-Test

	N	X	t	d	p
Pre-test	25	3.59	2.72	.54	.01
Post-test	25	3.85			

According to Table 10, the mean perception of problem-solving skills increased from 3.59 (pre-test) to 3.85 (post-test). The test value (t=2.72) and moderate effect size (d=0.54) indicate a significant positive effect on problem-solving skills ($p<0.05$).

References, tables, figures should be prepared in accordance with 7th edition of APA. The manuscripts that do not comply with the writing rules and APA style are rejected in the first evaluation by the editors. The author(s) should review the references and check their compliance with APA 7. Tables should be referred to in the text with the table number.

DISCUSSION

According to the results of this study, students found the process to be educational. The findings of Berglund (2003) also support this conclusion: PBL captures students' interest and motivates them towards learning. The literature indicates that gifted students hold positive views regarding learning through projects (Kiliçkiran & Korkmaz, 2021; Özbek & Dağyar, 2022). Additionally, PBL enhances students' motivation, learning skills, and abilities in scientific research and technology use (Demir, 2013; Korkmaz & Kaptan, 2001; Saban, 2002; Sünbül, 2007). Furthermore, this approach has positive outcomes in terms of research and inquiry (Kiliçkiran & Korkmaz, 2021), critical thinking (Suprapto et al., 2024), creativity (Arabacı & Baki, 2023), and learning autonomy (Çetinkaya, 2021). According to the results of this study, gifted students believe that PBL helps them find different solutions to problems. Korkmaz (2002) found that PBL has a positive effect on students in terms of academic risk-taking. This study supports this finding: Students reported improved skills in accessing information, documents, and resources, and processing the obtained data. Participants in this study also

showed increased motivation for conducting academic research and producing projects. A well-designed project increases students' interest and desire, while also enhancing leadership and decision-making skills (Zimmerman, 2010; Suprapto, Rizki, & Cheng, 2024; Özbek & Dağyar, 2022).

The pre-test and post-test results on problem-solving skills among the gifted students who participated in the project-based learning revealed a significant and positive change in their perceptions of problem-solving skills. This outcome aligns with findings from other studies. The literature suggests that PBL enhances students' problem-solving skills (Dori & Tal, 2000; Kaptan & Korkmaz, 2002).

CONCLUSION AND IMPLICATIONS

Project experience: Most students had previous project training experience and found the current training more practical and detailed. Some appreciated the hands-on project management aspect, while one suggested more individualization.

Expectations: Students mainly expected to acquire academic writing and scientific research skills. Some aimed to learn more about preparing presentations and using academic language, while others anticipated the training to be like previous experiences.

Opinions about the project training: post-training, students provided feedback on the process, trainers, and their personal experiences. They found the training educational, though time was sometimes insufficient. The trainers were seen as guiding, equipped, and sympathetic. Students generally found the training instructive and occasionally fun, though a few found it boring.

Personal development: Students reported improvements in academic writing, reporting, and presentation skills. They also felt their scientific research methods, creative and analytical thinking skills, curiosity, and research motivation were enhanced.

Problem-solving skills: Project training helped develop problem-solving skills, enabling students to find different solutions, be patient and determined, build self-confidence, face problems, and stay calm.

Academic development and competences: The training contributed to academic development, enhancing skills in accessing information, processing data, and conducting article-project work. Students felt more competent in using resources effectively and accessing reliable information.

The quantitative analysis showed a significant increase in problem-solving skill perceptions post-training. Participants had a more positive perception of their problem-solving abilities, confirmed by the test value and moderate effect size.

According to the literature, possessing project-based learning and project production skills offers numerous benefits for gifted students. The results of this research indicate that enhancing the project production and reporting skills of gifted students positively impacts their academic and personal development, as well as their problem-solving abilities. Considering these findings, it is recommended that a PBL approach be preferred in the education of gifted students, and that these students be encouraged to engage in project production activities.

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