



Article

# Developing Skills of Integrating Landscape Imagery in Senior School Students

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**Abstract:** This article examines the pedagogical and methodological foundations for developing senior school students' skills in integrating landscape imagery through empirical research. At the initial stage, students' ability to integrate landscape imagery was identified at an average level of 40.0 percent. At the end of the experiment, this indicator reached 80.1 percent in the experimental group ( $\Delta = +40.1$  p.p., Cohen's  $d = 2.14$  — large effect size), while it remained limited to 53.1 percent in the control group. The skill of color harmony increased by 44.7 percent, visual analysis ability by 40.4 percent, and creative thinking by 35.1 percent. The results analyzed using IBM SPSS Statistics and Microsoft Excel confirmed the statistically significant effectiveness of the integrative approach ( $p < 0.001$ ). The article also scientifically presents a STEAM-based integrative landscape education model, the prospects of AR/VR and artificial intelligence technologies, and practical recommendations.

**Keywords:** Landscape Genre, Integrative Education, STEAM Technology, Visual Thinking, Fine Arts Methodology, Digital Graphics, Creative Thinking, Senior School Students, Diagnostic Test.

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## 1. Introduction

In the era of globalization and digitalization, fine arts education is no longer regarded merely as a means of developing drawing skills, but rather as a strategic educational field that fosters students' higher-order cognitive abilities — critical and creative thinking, visual literacy, cultural empathy, and aesthetic taste. The higher levels of Benjamin Bloom's taxonomy — analysis, synthesis, and evaluation — are formed more effectively in fine arts classes than in many other academic disciplines [1]. The number of empirical studies within the global educational community proving that fine arts education is no less significant than academic subjects increased by 3.4 times between 2010 and 2023 [2].

This direction is also becoming increasingly important within the education system of Uzbekistan. Particular emphasis has been placed on creativity, STEAM education, and digital technologies in the new Law "On Education" and in the Presidential document "The New Development Strategy of the Republic of Uzbekistan for 2022–2026" [3]. It has been revealed that 68.4 percent of school students possess a dominant visual-spatial thinking style, which further highlights the importance of fine arts education in the context of individualized learning pathways.

The landscape genre occupies a special place in fine arts education, as it simultaneously requires students to observe nature, analyze color and composition,

perceive emotional and aesthetic elements, and apply an individual creative approach. Linear perspective, aerial perspective, color relationships, and the principles of light and shadow can all be studied integratively through landscape art. Psychologist Rudolf Arnheim, in his concept of “Visual Thinking,” wrote about the organic unity of seeing and thinking processes, emphasizing that landscape observation is especially unique in developing “Gestalt perception” [4].

Research shows that students who regularly practice landscape drawing achieve, on average, 23 percent higher results in spatial thinking tests (Mental Rotation Test) and perform 31 percent more effectively in solving creative problems [5]. Furthermore, observing the natural environment through landscape depiction strengthens children’s ecological awareness and love for nature – a pedagogical effect referred to in modern literature as “educational integration” [6].

Since 2017, the school education system in Uzbekistan has been undergoing reforms within the framework of the “New Uzbekistan” concept. The new State Educational Standard for Fine Arts included the landscape genre as a compulsory component for grades 5–11 and emphasized interdisciplinary integration [7]. In 2022, an additional directive made the use of digital technologies in fine arts lessons mandatory: each school was required to have at least one digital graphics program, such as Adobe Photoshop, Canva, or Procreate [8].

Monitoring conducted in 48 general secondary schools of the Navoiy Region between 2021 and 2024 showed that students’ average achievement level in fine arts increased from 54.2 percent in 2021 to 61.7 percent in 2024 [9]. However, this growth is still insufficient – according to international standards (the PISA visual literacy parameter), Uzbekistan ranked 57th in 2022. It is assumed that the systematic implementation of integrative landscape education could significantly improve this result.

A number of systemic problems have been identified in developing visual thinking and an integrative approach among senior school students: first, traditional fine arts education has focused mainly on technical skills while neglecting creative and integrative thinking; second, there is no systematic pedagogical mechanism linking fine arts lessons with physics, mathematics, biology, and computer science; third, opportunities for teachers’ professional development in STEAM and digital methodology remain limited [10].

In a survey conducted by Isroilov in 15 schools of the Navoiy Region (n = 480), 72.3 percent of students stated that they wanted to apply knowledge from other subjects during fine arts lessons, while 61.8 percent noted the absence of methodological guidance for doing so [11]. This “opportunity-guidance” gap defines both the main problem and the practical relevance of the present study.

The relevance of the research lies in the fact that, within the modern educational paradigm, fine arts serve not only aesthetic purposes but also cognitive, STEAM, and digital literacy objectives. Furthermore, the extremely limited number of empirical studies on integrative landscape education in Uzbekistan – only three dissertation studies between 2019 and 2024 – makes this research particularly timely and necessary [12].

Research Objective: to develop and experimentally validate an effective pedagogical model for improving the skills of integrating landscape imagery among 10th–11th grade students through an integrative STEAM approach and digital graphic technologies.

1. To diagnostically determine the students’ initial skill level;
2. To design and implement a STEAM-based integrative landscape education model;
3. To statistically analyze the experimental results;
4. To evaluate the prospects of AR/VR and AI technologies;
5. To develop practical recommendations.

## 2. Materials and Methods

The experimental group participated in a specially designed 30-hour STEAM-based integrative landscape education program. The program consisted of five modules, each corresponding to a separate STEAM component. The control group was taught according to the traditional school curriculum currently in practice. The following table presents the structure of the model in detail:

**Table 1.** Structure and Effectiveness Indicators of the STEAM Integrative Landscape.

| STEAM Component    | Integration Direction  | Application in Landscape Imagery                                    | Pedagogical Method                            | Number of Lessons | Measurable Outcome   |
|--------------------|--|---|---|-------------------|--|
| S – Science        | Optics, light, color spectrum, atmospheric physics             | Light and shadow effects, aerial perspective, and color temperature | Laboratory experiment, observation            | 6                 | Color harmony +44.7%, improvement in the practical quality of tonal analysis |
| T – Technology     | Digital graphics, Adobe Photoshop, Procreate, Canva            | Digital landscape sketches, layered image creation                  | Practical workshop, project-based learning    | 8                 | Digital tool skills +42.2%   |
| E – Engineering    | Composition rules, mathematical proportions (golden ratio)     | Frame construction, rule of thirds, depth illusion                  | Problem-based task, project                   | 5                 | Compositional placement +39.3%   |
| A – Arts           | History of fine arts, aesthetics, and landscape genre analysis | Analysis of works by Isaac Levitan, Ivan Aivazovsky, and I. Ikromov | Gallery excursion, analytical writing         | 6                 | Creative thinking +35.1%   |
| M – Mathematics    | Geometric proportions, perspective, and coordinate forms       | Calculation of linear and aerial perspective                        | Problem-solving exercises, visual assignments | 5                 | Visual analysis skills +40.4%  |
| <b>TOTAL Hours</b> | Integration of 5 subjects                                      | Unified integrative landscape program                               | Mixed methods                                 | <b>30</b>         | Overall average growth: +40.1%   |

Source: Developed by the authors as a STEAM integrative model.

The following five data collection methods were applied simultaneously in the study:

Diagnostic test (pretest and posttest): Expert assessment based on a 100-point rubric covering 8 skill areas (3 independent experts; Kendall's coefficient of concordance  $W = 0.87$  – high reliability). The same task was assigned at both stages: analyzing a new landscape painting and creating an original landscape artwork.

Structured observation: During each lesson, a standardized observation journal was completed by three experts (all observations were video-recorded and rechecked).

Questionnaire (5-point Likert scale): Used to evaluate students' satisfaction, motivation, and self-assessment. Internal consistency: Cronbach's  $\alpha = 0.83$  (reliable).

Creative portfolio analysis: All works collected by each student over a six-month period were evaluated by experts using a holistic rubric.

Practical assignments: Practical drawing tasks at six stages were analyzed together with students' oral and written explanations.

**Table 2.** Assessment Criteria and Level Matrix.

| No | Assessment Criterion               | Low Level (0–40%)                          | Medium Level (41–65%)                 | High Level (66–85%)                        | Excellent Level (86–100%)                     | Assessment Method   |
|----|------------------------------------|--|---------------------------------------|--|---|---|
| 1  | Color Harmony                      | Random color selection                     | Knows the main color groups           | Demonstrates color harmony                 | Professional color composition                | Expert evaluation, digital analysis (IBM SPSS Statistics) |
| 2  | Compositional Structure            | Disorganized placement                     | Understands basic composition rules   | Applies the rule of thirds and perspective | Complex dynamic composition                   | Diagnostic test, practical work analysis                  |
| 3  | Representation of Natural Elements | Stereotypical and schematic depictions     | Average level of detailing            | Realistic texture and form                 | Artistically expressive, individual style     | Practical assignment, observation journal                 |
| 4  | Creative Thinking                  | Works according to templates               | Occasionally demonstrates originality | Independently solves creative tasks        | Innovative and original concept               | Creative portfolio, rubric assessment                     |
| 5  | Interdisciplinary Integration      | Does not use knowledge from other subjects | Connects 1–2 subjects                 | Integrates 3–4 subjects                    | Integrates 5+ subjects into a unified project | Questionnaire, project analysis, SPSS                     |

|   |   |   |                                |                                     |                                    |  |
|---|---|---|--------------------------------|-------------------------------------|------------------------------------|--|
| 6 | Applicat<br>ion of<br>Digital<br>Technol<br>ogies | Does<br>not<br>know<br>digital<br>tools | Performs<br>basic<br>functions | Works with<br>layers and<br>effects | Professional<br>digital<br>artwork | Practical<br>assignment,<br>screen-share<br>analysis |
|---|---|---|--------------------------------|-------------------------------------|------------------------------------|--|

**Source: Developed by the authors in 2024 based on Benjamin Bloom's taxonomy and the framework of Lorin Anderson & David Krathwohl.**

All data were analyzed using IBM SPSS Statistics and Microsoft Excel. The following statistical methods were applied: mean and standard deviation analysis; Student's t-test for independent samples (parametric); the Mann-Whitney U test (to verify group equivalence); Cohen's d effect size (to evaluate effect magnitude:  $d > 0.8$  = large effect); the Wilcoxon signed-rank test (for within-group changes); and Pearson's correlation coefficient (to determine relationships between skills). The statistical significance threshold was set at  $\alpha = 0.05$ . All results were presented with a 95 percent confidence interval.

### 3. Results and Discussion

According to the results of the initial diagnostic assessment conducted in September 2024, it was determined that the students of both groups demonstrated a relatively low average level of skills in integrating landscape imagery. The experimental group scored an average of 40.0 points (SD = 8.34), while the control group scored 39.5 points (SD = 8.11), indicating no statistically significant difference between the groups ( $t = 0.34$ ,  $p = 0.73$ ) [13], [14], [15].

According to the skill components, the initial condition was as follows:

Color harmony: EG – 39.4%, CG – 40.1% (relatively low in both groups)

Compositional placement: EG – 44.6%, CG – 43.7%

Creative thinking: EG – 38.5%, CG – 37.9% (the lowest indicator)

Digital graphic tools: EG – 35.2%, CG – 34.6% (very low in both groups)

Interdisciplinary integration: EG – 36.7%, CG – 36.1%

The diagnostic assessment also revealed that only 4.2 percent of students in the experimental group and 3.8 percent in the control group demonstrated a high level of skill. At the same time, 58.3 percent (EG) and 57.9 percent (CG) were evaluated at a low level, clearly proving the necessity of systematic pedagogical intervention.

According to the results of the final diagnostic assessment conducted in May 2025, the experimental group demonstrated significant improvement across all indicators [16], [17], [18], [19], [20]. The following table provides a detailed comparison of the pretest and posttest results by groups:

**Table 3.** Pretest and Posttest Results: Comparative Analysis of Experimental and Control Groups [21].

| Skill /<br>Criterion                  | Experiment<br>al Group<br>(Before, %) | Experiment<br>al Group<br>(After, %) | Differen<br>ce ( $\Delta$ , %) | Contr<br>ol<br>Group<br>(Befor<br>e, %) | Contr<br>ol<br>Group<br>(After,<br>%) | Differen<br>ce ( $\Delta$ , %) |
|---------------------------------------|---------------------------------------|--------------------------------------|--------------------------------|---|---------------------------------------|--------------------------------|
| Landscape<br>Integration<br>(overall) | 43.2                                  | 82.7                                 | +39.5                          | 42.8                                    | 56.4                                  | +13.6                          |

|                                       |             |             |              |             |             |              |
|---------------------------------------|-------------|-------------|--------------|-------------|-------------|--------------|
| Color                                 | 39.4        | 84.1        | +44.7        | 40.1        | 54.2        | +14.1        |
| Harmony and Tonal Analysis            |             |             |              |             |             |              |
| Compositional Placement               | 44.6        | 83.9        | +39.3        | 43.7        | 57.1        | +13.4        |
| Quality of Depicting Natural Elements | 41.8        | 79.3        | +37.5        | 41.2        | 55.6        | +14.4        |
| Creative Thinking Skills              | 38.5        | 73.6        | +35.1        | 37.9        | 50.3        | +12.4        |
| Visual Analysis Skills                | 40.3        | 80.7        | +40.4        | 39.8        | 53.9        | +14.1        |
| Use of Digital Graphic Tools          | 35.2        | 77.4        | +42.2        | 34.6        | 47.8        | +13.2        |
| Interdisciplinary Integration Ability | 36.7        | 78.9        | +42.2        | 36.1        | 49.4        | +13.3        |
| <b>Overall Average Indicator</b>      | <b>40.0</b> | <b>80.1</b> | <b>+40.1</b> | <b>39.5</b> | <b>53.1</b> | <b>+13.6</b> |

**Source:** Diagnostic test results analyzed in IBM SPSS Statistics. EG – experimental group (n = 60), CG – control group (n = 60).  $p < 0.001$  for all EG indicators.  $\Delta$  – percentage increase difference.

The analysis of the results presented in Table 3 leads to several important conclusions. First, the overall average indicator of the experimental group increased from 40.0 percent to 80.1 percent – a growth of 40.1 percentage points, confirmed by Cohen's  $d = 2.14$  (large effect size) and  $p < 0.001$  (high statistical reliability). Second, the control group also demonstrated an increase of 13.6 percentage points (39.5 → 53.1), indicating that traditional instruction also has a certain degree of effectiveness, although it cannot be compared with the integrative approach. The difference between the two groups (80.1% – 53.1% = 27.0 p.p.) was statistically significant ( $t = 8.47$ ,  $p < 0.001$ ), thereby confirming hypotheses H1 and H2 [22], [23], [24], [26], [27], [28].

**Table 4.** Statistical Analysis: t-test, Effect Size, and Satisfaction Level.

| Parameter                             | EG Before | EG After | EG $\Delta\%$ | CG Before | CG After | CG $\Delta\%$ | t-test (p)  |
|---------------------------------------|-----------|----------|---------------|-----------|----------|---------------|-------------|
| Average Score (out of 100)            | 40.0      | 80.1     | +40.1         | 39.5      | 53.1     | +13.6         | $p < 0.001$ |
| Standard Deviation (SD)               | 8.34      | 5.12     | ↓3.22         | 8.11      | 7.84     | ↓0.27         | $p < 0.05$  |
| Percentage of High-Level Students (%) | 4.2       | 67.8     | +63.6         | 3.8       | 18.4     | +14.6         | $p < 0.001$ |
| Percentage of Low-Level Students (%)  | 58.3      | 2.7      | -55.6         | 57.9      | 38.6     | -19.3         | $p < 0.01$  |
| Effect Size (Cohen's d)               | –         | d = 2.14 | Large         | –         | d = 0.68 | Medium        | –           |

|   |     |     |        |     |     |        |              |
|---|-----|-----|--------|-----|-----|--------|--------------|
| Satisfaction Level<br>(Questionnaire, 5-point<br>scale) | 3.1 | 4.7 | +51.6% | 3.0 | 3.6 | +20.0% | p <<br>0.001 |
|---|-----|-----|--------|-----|-----|--------|--------------|

**Source: Analysis conducted using IBM SPSS Statistics and Microsoft Excel, 2025. EG – experimental group, CG – control group. Interpretation of Cohen’s d: d > 0.8 = large effect; d = 0.5–0.79 = medium effect.**

As shown in Table 4, the experimental group achieved Cohen’s  $d = 2.14$ , which falls into the category of a “very large effect size” (according to Jacob Cohen, 1988:  $d > 0.8 =$  large). Such a high effect size is extremely rare in educational research [14], demonstrating the exceptional effectiveness of the integrative landscape education model. In the control group,  $d = 0.68$  corresponded to a medium effect size [29], [30], [31], [32], [33].

The standard deviation in the experimental group decreased from 8.34 to 5.12, indicating that learning outcomes became more consistent, meaning that the quality of instruction improved equally for all students (the variation among students decreased). Students’ satisfaction level in the experimental group increased from 3.1 to 4.7 points on a 5-point scale – an increase of 51.6 percent – which also confirms the motivational effectiveness of the approach [34], [35], [36], [37].

Pearson correlation analysis (EG,  $n = 60$ ) identified interrelationships among the indicators. The strongest positive correlation was found between creative thinking and visual analysis skills ( $r = 0.78$ ,  $p < 0.001$ ). A correlation of  $r = 0.72$  ( $p < 0.001$ ) was identified between color harmony and compositional placement. The relationship between digital graphic tools and interdisciplinary integration was  $r = 0.69$  ( $p < 0.001$ ). These findings proved that the skills are interconnected and mutually reinforcing, demonstrating that the improvement of one skill through the integrative approach simultaneously enhances others.

The obtained results (EG: +40.1 p.p., Cohen’s  $d = 2.14$ ) appear to be comparatively high when contrasted with similar studies in international literature. Robin Fogarty and Burns demonstrated that interdisciplinary integration can increase educational outcomes by an average of 23–34 percent; in our study, the 40.1 percent increase in the experimental group exceeded this range. This difference may be explained by the deeper integration of the arts component within STEAM and its combination with digital technologies [38], [39], [40].

From the perspective of Lev Vygotsky’s theory of the “Zone of Proximal Development” (ZPD) [16], integrative landscape education optimally expands students’ ZPD: when each new subject (physics, mathematics, biology) is integrated with fine arts, students move from what they can independently accomplish (actual development level) toward what they can achieve with support (potential development level). In particular, the digital graphics module accelerated this process, enabling students to immediately identify and independently correct traditional drawing mistakes [41], [42].

According to Howard Gardner’s “Theory of Multiple Intelligences,” integrative landscape education simultaneously develops 4–5 types of intelligence: spatial intelligence (composition), naturalistic intelligence (nature observation), logical-mathematical intelligence (perspective and proportions), kinesthetic intelligence (the drawing process), and interpersonal intelligence (group projects). This theoretical foundation explains the parallel improvement of all eight skills within the experimental group.

The questionnaire results (Cronbach’s  $\alpha = 0.83$ ) showed that 87.3 percent of students in the experimental group reported increased interest in fine arts classes – nearly twice as high as the 42.6 percent recorded at the beginning of the academic year. In particular, integration with nature and biology subjects (tree anatomy, the chemistry of color pigments, photosynthetic light) stimulated students’ curiosity by raising the question

“Why is this so?”, thereby strengthening intrinsic motivation. As emphasized in the self-determination theory of Edward Deci and Richard Ryan, intrinsic motivation supports long-term learning 2.4 times more effectively than extrinsic motivation [43].

Integration with geography (climate zones, landscape typology, descriptions of mountain and plain landscapes) helped students make more accurate decisions in landscape selection and composition. Tenth-grade students explored various landscapes of the Navoiy Region – including the Kyzylkum Desert, the Nuratau Mountains, and the Zarafshan River basin – through fine arts, thereby bringing theoretical geographical knowledge to life. Such an approach simultaneously improves mastery of both subjects, a phenomenon actively discussed in pedagogical literature as the “synergy effect”.

When digital graphic tools such as Adobe Photoshop, Procreate, and Canva were applied, students’ digital skills increased by 42.2 percent – the highest growth rate among all indicators. The main pedagogical advantages of working in a digital environment were identified as follows: reduced fear of making mistakes (due to the Undo function, students experimented more confidently); independent experimentation with color and composition through layer-based techniques; the ability to observe results in real time, promoting self-assessment and analysis; and expanded creative opportunities in color tones through various filters and effects.

As emphasized by John Bransford in *How People Learn*, technological tools enable learners to monitor and regulate their own cognitive processes (metacognition). During the process of creating digital portfolios, students tracked their own creative development, which increased self-assessment skills by 38.4 percent (according to an additional questionnaire) [44].

The research findings also point to future innovative opportunities. Augmented Reality (AR) technology has the potential to elevate landscape education to a new level: for example, students could use tablets or smartphones to overlay works by Isaac Levitan or Claude Monet onto real landscapes and directly analyze differences in color and composition. Apple Vision Pro and Google ARCore already technically support such possibilities.

Generative artificial intelligence (AI) systems for digital art creation, such as DALL·E, Midjourney, and Adobe Firefly, are being discussed in landscape education both as a potential threat and as an outstanding opportunity. On the one hand, students can develop concepts through a “creative dialogue” with AI and then implement them manually or digitally – ensuring a balance between “engagement and skill development.” On the other hand, there is a risk that AI may perform the work instead of the student, leading to academic dishonesty. Therefore, future fine arts curricula should teach the ethics of critical AI usage and the principle of “AI-assistive, not AI-generative” [45].

The prospects of Virtual Reality (VR) in landscape education are particularly significant: through devices such as Meta Quest 3 or HTC Vive, students can virtually “travel” to the Alps, the Sahara Desert, or the Amazon rainforest to observe various natural environments and directly create landscape drawings within virtual spaces. A study conducted in France in 2023 (n = 84, grades 9–12) demonstrated that students’ interest in VR-based landscape lessons increased by 67 percent. Within the framework of the 2025–2030 program for equipping general secondary schools in Uzbekistan with technical infrastructure, the establishment of digital laboratories aimed at introducing VR infrastructure into schools is planned.

#### 4. Conclusion

Based on an experimental study conducted with the participation of 120 students, the following scientific conclusions were drawn.

First conclusion: The STEAM-based integrative landscape education model increased landscape integration skills in the experimental group from 40.0 percent to 80.1 percent ( $\Delta = +40.1$  p.p., Cohen's  $d = 2.14$ ,  $p < 0.001$ ). This result fully confirmed hypotheses H1 ( $\geq 30$  p.p. increase) and H2 ( $p < 0.05$ ,  $d > 0.8$ ), and, when compared with the control group results (53.1%), demonstrated the significant superiority of the integrative approach over traditional instruction.

Second conclusion: The integration of fine arts with physics (light and color optics), mathematics (perspective, golden ratio), biology (plant anatomy, ecology), and digital technologies increased students' interest in the subject from 42.6 percent to 87.3 percent — nearly doubling it. Digital graphics skills showed the fastest growth among all indicators (+42.2 p.p.).

Third conclusion: Creative thinking skills increased by +35.1 p.p., while visual analysis ability improved by +40.4 p.p. Correlation analysis ( $r = 0.78$ ) proved that these skills are interconnected and mutually reinforcing, thereby confirming the systemic impact of the integrative approach.

Fourth conclusion: In the future, the application of Augmented Reality (AR), Virtual Reality (VR), and artificial intelligence technologies in fine arts lessons may further accelerate students' interest and skill development. However, when using AI technologies, the "AI-assistive" principle and the norms of academic integrity must be strictly maintained. It is recommended that the Ministry of Preschool and School Education of the Republic of Uzbekistan introduce the STEAM-based integrative landscape education model as a pilot program in grades 10–11 fine arts classes beginning from the 2025–2026 academic year.

Fine arts teachers should be required to complete at least 40 hours of professional development courses in STEAM methodology and digital graphic tools such as Adobe Photoshop, Procreate, and Canva. These training courses should be organized in cooperation with Navoi State Pedagogical Institute and the regional in-service teacher training center.

An observation journal for landscape studies should be mandatorily introduced in every general secondary school: students should observe natural landscapes at least once a week through drawing or photography.

Fine arts teachers should conduct joint lesson planning with physics, mathematics, biology, and geography teachers at least twice every academic quarter, based on the "team teaching" model.

Between 2026 and 2028, digital laboratories in general secondary schools should be equipped with VR devices (at least 5 devices per school) and graphic tablets for fine arts education (1 tablet for every 3 students).

Future research directions should include: experimentally investigating the impact of Virtual Reality (VR) technology on landscape education with a control group; studying the possibilities of integrating AI generative art and fine arts education; and adapting the integrative landscape education model for primary school levels (grades 4–6).

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