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Naked-Eye Astronomical-Viewing Image Toys and the Cultivation of Adolescents' Visual Thinking

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Abstract: In the digital age, adolescents are immersed in fragmented screen-based visual scenarios for a long time, suffering from problems such as weak macro visual perception, deficient spatial thinking, and narrow aesthetic horizons. To meet adolescents' demands for astronomical light-shadow cognition and cosmic space visual enlightenment, naked-eye astronomical-viewing image toys feature lightweight and immersive astronomical light-shadow puzzle-game attributes. Relying on functions including star-sky simulation projection, celestial body light-shadow restoration, and astronomical phenomenon chronological demonstration, they take direct naked-eye observation as the core and convert abstract astronomical optics, spatial perspective, and logical rules of astronomical phenomenon movements into interesting experiences. Taking such toys as the research object, this paper analyzes the products' media characteristics, aesthetic education values, and empowerment logic, explores their cultivating effects on adolescents' light-shadow perception, spatial deconstruction, chronological cognition, and visual creation capabilities, makes up for adolescents' deficiencies in macro visual literacy, and helps shape three-dimensional and dynamic high-order visual thinking.

Keywords: Naked-eye astronomical-viewing image toy; Visual thinking; Astronomical aesthetic education; Light-shadow perception

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1. Origin

1.1. Research background

From ancient times to the present, Orion and the Great Summer Triangle have always drawn people to look up at the sky. Nowadays, however, adolescents are constantly exposed to close-range, small-frame flat visual content, lacking perception of grand-scale space, long-distance light-shadow gradations, and natural chronological movements. Their visual thinking tends to be fragmented and superficial [1]. Naked-eye astronomical-viewing image toys focus on astronomical light-shadow experiences, lower thresholds for

operation and knowledge, and restore night-sky light-shadows, star-sky structures, and dynamic astronomical phenomena [2]. Research on such products can not only expand the design value and application scenarios of astronomical puzzle toys, but also provide new paths for the enlightenment of adolescents' visual thinking, which bears both industrial and aesthetic education research value.

1.2. Domestic and foreign research status

Overseas systems for visual education and toy-based aesthetic education are relatively mature. Arnheim's visual thinking theory points out that immersive visual experience is the key to cognitive construction [3]. The industrialization of overseas astronomical popular science toys started early. Both industry and academia recognize the enlightening effects of lightweight astronomical toys on adolescents' spatial perception and natural aesthetics, and advocate interesting experiences instead of theoretical preaching. Domestic research mostly focuses on traditional fine arts aesthetic education, ordinary light-shadow toys, and astronomical popular science. Special research targeting naked-eye astronomical-viewing image toys is still lacking. Existing studies fail to distinguish the essential differences between ordinary light-shadow toys and astronomical-observation toys, ignore the educational attributes of astronomical phenomenon experiences represented by macro-scope, chronology, and spatiality, and lack in-depth exploration of how such toys empower high-order visual thinking [4]. For this reason, this paper carries out special research to fill gaps in this segmented field and provide theoretical support for the iteration of astronomical puzzle toys.

1.3. Research purpose and significance

1.3.1. Research purpose

Taking naked-eye astronomical-viewing image toys as the core research object, this paper defines the exclusive media attributes and core characteristics of such products. Proceeding from the toys themselves and breaking away from the perspective of traditional teaching research, it explores their empowerment mechanisms for adolescents' macro-visual perception, spatial deconstruction, dynamic chronological thinking, and creative visual capabilities. It sorts out exclusive paths for astronomical light-shadow toys to cultivate visual thinking, and offers theoretical references for the innovative design, scenario expansion, and value upgrading of astronomical puzzle toys.

1.3.2. Research significance

Theoretically, this paper extends visual-thinking theory to the research field of astronomical puzzle toys, refines the educational value of segmented categories of light-shadow toys, clarifies the aesthetic education and popular-science attributes that distinguish naked-eye astronomical-viewing image toys from ordinary light-shadow toys, and enriches the interdisciplinary research system of toy-oriented education and public aesthetic education [5]. Practically, this paper systematically analyzes the product advantages and experience values of naked-eye astronomical-viewing image toys, verifies their product characteristics of low threshold, high interest, and strong empowerment, and puts forward practical ideas for the R&D optimization, market promotion, and diversified-scenario application of astronomical puzzle toys. It promotes the puzzle-toy industry to upgrade from a single entertainment attribute to diversified values of "entertainment + popular science + aesthetic education."

1.4. Research methods

Two main research methods are adopted in this paper. First, the literature-research method: systematically sort out relevant theoretical achievements concerning visual thinking, visual-perception psychology, astronomical popular science, and light-shadow toy design, consolidate the research foundation, and clarify the educational logic and research boundaries of astronomical light-shadow toys. Second, the inductive research method: combined with product forms, functional characteristics, and experience modes of naked-eye astronomical-viewing image toys, induce their media advantages, educational paths, and existing industrial problems, and propose feasible strategies for product optimization and value realization.

2. Definition of core concepts

2.1. Definition of naked-eye astronomical-viewing image toy

Naked-eye astronomical-viewing image toys refer to lightweight, puzzle-based popular-science toys centered on astronomical phenomenon light-shadow experiences and adopting pure direct naked-eye observation as the experience form. Their core functions include star-sky simulation, celestial-body light-shadow restoration, day-and-night astronomical phenomenon switching, chronological operation of constellations, and night-sky gradation display. Based on physical light-shadow imaging principles, they require no electronic screens, lens framing, or post-processing. Immersive astronomical light-shadow experiences can be obtained through direct naked-eye viewing. Their simple operations fit adolescents' cognitive characteristics. Different from ordinary color-and-animation projection toys available on the market, they take macro astronomical scenarios and dynamic astronomical phenomena as the core, and feature astronomical phenomenon orientation, macro-scope, spatiality, and chronology. They are innovative astronomical light-shadow toys integrating entertainment, popular science, and aesthetic education [6].

2.2. Exclusive media characteristics of naked-eye astronomical-viewing image toys

Compared with ordinary puzzle-based light-shadow toys, they possess four core characteristics. First, immersive naked-eye experience: free from equipment barriers and operation thresholds, conforming to human-eye viewing habits, restoring real perceptions of outdoor sky-viewing and getting rid of constraints from electronic devices. Second, visualization of macro light-shadows: convert hard-to-observe macro contents such as star-sky distribution, light-shadow gradations, and spatial depth into close-range visible light-shadows, solving difficulties in observing natural astronomical phenomena [7]. Third, simulatability of dynamic chronology: restore star-sky rotation, alternation between day and night, and constellation displacement, and combine static space with dynamic astronomical phenomena to add the time-dimension experience. Fourth, strong inclusive adaptability: lightweight and easy-to-use, free of cognitive burdens, suitable for adolescents of all age groups and conducive to large-scale popularization.

2.3. Core connotation of visual thinking

Combining Arnheim's visual-thinking theory with the scenarios of this product, visual thinking in this paper refers to adolescents' comprehensive capabilities of visual perception, picture judgment, spatial deconstruction, aesthetic association, and innovative cognition generated when observing simulated night-sky light-shadows, celestial bodies, and dynamic astronomical phenomena. Different from flat and superficial cognition brought by ordinary toys, visual thinking under astronomical scenarios emphasizes macro vision,

discrimination of spatial depth, mastery of light-shadow order, and perception of dynamic chronology. It belongs to a systematic and high-order form of visual cognition.

2.4. Differences between naked-eye astronomical-viewing image toys and ordinary puzzle toys

Most puzzle and light-shadow toys on the market are based on micro-life scenarios. Relying on static flat surfaces, monochromatic light-shadows, and interesting special effects, they only provide basic entertainment and superficial visual cognition, with limited experience and cognitive horizons. Breaking away from life-oriented scenarios, naked-eye astronomical-viewing image toys take the macrocosmic night sky as the carrier, integrating spatial structures and astronomical phenomenon chronology. Beyond entertainment, they help adolescents build macro-space awareness, chronological thinking, and high-order aesthetics, accomplishing a value leap from entertainment to thinking cultivation. They exert irreplaceable educational effects that ordinary puzzle toys cannot achieve.

3. Exclusive product and aesthetic education advantages of naked-eye astronomical-viewing image toys

3.1. Breaking limitations of traditional toys and filling gaps in macro visual experiences

Most mainstream puzzle toys on the market focus on micro perspectives and flat visual presentation. Long-term exposure to such single visual experiences tends to limit adolescents' cognitive horizons and makes it difficult for them to perceive grand spatial scales and change rules of large-scale natural light-shadows [8]. Taking the complete night sky as the visual carrier and adopting immersive light-shadow presentation forms, naked-eye astronomical-viewing image toys create multi-layered and three-dimensional macro-visual-experience scenarios for adolescents and broaden their visual-cognitive horizons.

3.2. Reproducing natural astronomical light-shadows and empowering scientific-aesthetics enlightenment

Light-shadows of natural night skies carry unique order attributes and aesthetic values. The dense-sparse distribution of stars, gradational transitions of light and shade, and superimposed picture layers contain both basic natural-scientific principles and high aesthetic-appreciation significance. Naked-eye astronomical-viewing image toys highly restore light-shadow features of natural night skies. In fun-filled immersive experiences, adolescents can intuitively feel the sense of balance, rhythm, and gradation of natural light-shadows, get rid of rigid aesthetic thinking brought by artificial stereotyped light-shadows, and construct high-order macro-aesthetic cognition in line with natural laws.

3.3. Integrating dual dimensions of time and space and building three-dimensional cognitive systems

Different from the experience modes of single static display or simple dynamic demonstration adopted by ordinary toys, naked-eye astronomical-viewing image toys feature dual core attributes of static spatial presentation and dynamic chronological demonstration [9]. In the static dimension, the products completely restore night-sky spatial frameworks, celestial body distribution rules, and interstellar perspective relations, helping adolescents form intuitive and three-dimensional cognition of cosmic space. In the dynamic

dimension, they accurately simulate the whole operation process of astronomical phenomena, enabling adolescents to perceive the rhythm and chronological features of movements of natural celestial bodies. The complementary and organically combined dual experiences of time and space help adolescents build complete and three-dimensional visual-cognitive and natural-scientific cognitive systems.

3.4. Upgrading visual experience modes and reshaping adolescents' cognitive logic of observation

Visual outputs of electronic screens and conventional toys are mostly passive and superficial fragmented contents, which may easily make adolescents develop bad habits of passive viewing and superficial cognition. Centering on active-exploratory, immersive, and holistic naked-eye visual experiences, naked-eye astronomical-viewing image toys guide adolescents to take the initiative to observe night-sky hierarchical structures, star-sky distribution orders, and dynamic changes of astronomical phenomena. They gradually cultivate adolescents' holistic and structured visual interpretation thinking, eliminate misunderstandings of fragmented and superficial viewing cognition, and realize thinking ability upgrading featured by "cognition through active observation and growth via immersive experiences" [10].

4. Exclusive cultivation paths of naked-eye astronomical-viewing image toys for visual thinking

4.1. Macro-visual perception: Refining cognition of night-sky light-shadow gradations

Compared with the high-contrast and flat single visual presentation of ordinary toys, naked-eye astronomical-viewing image toys highly reproduce soft and gradual light-and-shade gradations, interwoven virtual-real star-point effects and large-scale light-shadow transition textures of natural night skies [11]. The multi-layered and weakly-gradated visual features unique to astronomical light-shadows can effectively polish the delicacy of adolescents' visual perception, help them accurately distinguish gradation differences and rhythmic changes of large-scale light-shadows, break cognitive limitations of traditional flat and single-dimension perspectives, and consolidate the perceptual foundation for adolescents' macro visual thinking.

4.2. Holistic visual judgment: Holistically shaping cognitive thinking of star-sky order

The dense-sparse distribution of star points, primary-secondary picture relations, and light-and-shade rhythms presented by simulated star skies contain native visual balance orders of nature. In immersive naked-eye observation, adolescents can autonomously perceive visual focuses, aesthetic rhythms, and dense-sparse proportion logics of night-sky pictures, and gradually develop holistic visual-judgment capabilities. Different from the experience logic of ordinary toys that focuses on partial details, such products guide adolescents to control picture orders from a holistic perspective, effectively avoid fragmented cognitive biases, and cultivate high-order holistic visual thinking.

4.3. Spatial-deconstruction thinking: Three-dimensionally constructing cognitive systems of cosmic depth

The infinitely-extended night-sky visual scenarios created by the products convert abstract and obscure cosmic depth, far-near hierarchies of celestial bodies, and interstellar perspective relations into intuitive and perceivable light-shadow pictures [12]. Through long-term immersive experiences, adolescents can intuitively

perceive three-dimensional cosmic frameworks, learn to deconstruct night-sky spatial hierarchies and far-near distribution orders of celestial bodies, and gradually form systematic and three-dimensional cosmic-spatial thinking. They fill the gap in cultivating adolescents' macro-spatial deconstruction capabilities that cannot be covered by conventional puzzle toys.

4.4. Dynamic-chronological thinking: Systematically cultivating cognition of astronomical phenomenon operation rules

The products can dynamically and intuitively present a series of natural astronomical phenomenon movement processes, including star-sky rotation, celestial-body displacement, and alternation between day and night. They help adolescents clearly understand chronological changes of star skies from static layouts to dynamic operations and build complete cognitive systems in the time dimension [13]. In continuous dynamic observation, adolescents can accurately capture rhythmic rules and dynamic balance features of astronomical phenomenon movements, and gradually form dynamic visual-narrative thinking. They make up for the drawbacks of traditional static toys lacking cultivation of chronological cognition, and further enrich the dimensions and connotations of visual thinking.

4.5. Creative visual association: Aesthetically activating innovative thinking of star-sky imagery

Night-sky scenarios feature strong openness and imaginative space. Immersive star-sky atmospheres created by the products can fully stimulate adolescents' capabilities of visual association, aesthetic imagination, and creative construction [14]. Relying on star-sky light-shadow changes and dynamic features of astronomical phenomena, adolescents can carry out independent aesthetic interpretation and creative creation, realizing an upgrade from passive viewing-for-entertainment to active aesthetic construction. They promote all-round advancement of visual thinking from perception, judgment, and deconstruction to innovation, and facilitate long-term growth of adolescents' aesthetic-innovation capabilities.

5. Existing industrial problems and product optimization and development strategies

5.1. Existing development pain points of the astronomical light-shadow toy industry

The domestic astronomical light-shadow puzzle-toy industry is still in the initial development stage and suffers from quite a few deficiencies. First, one-sided understanding of product values: most consumers simply classify naked-eye astronomical-viewing image toys as ordinary entertainment toys and ignore their core astronomical popular-science and visual-aesthetic education values. Second, severe industrial homogenization: most similar toys on the market only have basic light-and-shadow special-effect functions, lack the construction of macro astronomical scenarios and the design of dynamic chronological astronomical phenomena, and high-quality high-end astronomical puzzle products are in short supply. Third, insufficient realization of educational functions: most products merely stay at the level of basic light-shadow display, without designing experience systems in accordance with the laws of adolescents' visual growth development.

5.2. Optimization and upgrading of naked-eye astronomical-viewing image toys and industrial development strategies

Targeting existing industrial problems, product upgrading and high-quality industrial development can be promoted from three dimensions. Firstly, reshape product value positioning: build diversified core positioning of "entertainment experience + astronomical popular science + visual aesthetic education," and highlight their unique advantages in cultivating adolescents' macro visual thinking. Secondly, deepen product function innovation: optimize the presentation precision of star-sky light-shadows and dynamic simulation effects of astronomical phenomena, enrich diversified experience scenarios, build differentiated product advantages, and fill market gaps for high-end astronomical puzzle toys. Finally, improve immersive experience cultivation systems: strictly follow the laws of adolescents' visual growth, realize multi-dimensional integrated experiences of light-shadows, space, and chronology, and achieve in-depth integration of entertainment experiences and thinking-oriented aesthetic education cultivation [15].

6. Conclusion

Naked-eye astronomical-viewing image toys are innovative astronomical light-shadow puzzle products. Centering on immersive naked-eye astronomical phenomenon experiences, they integrate dimensions of night-sky light-shadows, cosmic space, and astronomical phenomenon chronology, and make up for deficiencies of ordinary toys in cultivating macro-visual, spatial, and chronological cognition. This paper defines their media characteristics and product advantages, sorts out empowerment paths for visual thinking, and analyzes industrial pain points and improvement strategies. Featuring low thresholds, high interest, and prominent educational values, such products can guide adolescents to break away from micro-visual limitations and construct high-order visual thinking. Against the background of industrial transformation and public aesthetic education, they serve as new carriers for astronomical popular science and public aesthetic education, and offer new ideas for the innovation and upgrading of puzzle toys, hence possessing high promotion and R&D values.

Disclosure statement

The author declares no conflict of interest.

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